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Original Article

Clinical application of percutaneous endoscopic gastrostomy (PEG)/percutaneous radiologic gastrojejunostomy (PRGJ) technology

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Abstract: Objective: The aim of this study was to discuss the indications and efficacy of percutaneous endoscopic gastrostomy (PEG)/percutaneous radiologic gastrojejunostomy (PRGJ). Methods: A total of 104 PEG/PRGJ patients were divided into nervous system disease, digestive system tumor, non-digestive system tumor with eating difficulties, and other type of disease groups. We recorded the longest retained time (LTT), shortest retained time (STT), and average retained time (ATT) of the PEG/PRGJ tubes and compared albumin, pre-albumin, high-sensitivity C-reactive protein (Hs-CRP), the neutrophil-lymphocyte ratio (NLR), hemoglobin level, and Onodera Prognostic Nutrition Index (OPNI) within 1 week before and 4 weeks after catheter retention in the four groups. Results: In the nervous system disease group, mean ATT was 39.8±23.0 months, mean LTT was 60.0 months, and mean STT was 3.0 months. There were significant differences in albumin, Hs-CRP, NLR, and OPNI. In the digestive tract tumor group, the mean ATT was 6.5±2.1 months, mean LTT was 30.0 months, and mean STT was 0.6 months. There were significant differences in albumin and pre-albumin. In the non-digestive tract tumor group, the mean ATT was 18.4±6.8 months, mean LTT was 48.0 months, and mean STT was 3.0 months. There were significant differences in pre-albumin. In the other types of disease group, mean ATT was 29.0±11.3 months, mean LTT was 48.0 months, and mean STT was 24.0 months. There were significant differences in albumin, pre-albumin, and hemoglobin levels. The mean ATT for all patients was 17.8 months, while that for the nervous system group was 18.4 months. The overall complication rate was 13.4%. Conclusion: Nervous system diseases, advanced tumors causing obstruction of the digestive tract or eating difficulties, and some special types of diseases (e.g., short bowel syndrome) may be indications for PEG/PRGJ.

Keywords: PEG, PEJ, PRGJ, clinical application, indications

Introduction

Enteral nutrition is the preferred clinical nutritional support therapy, and percutaneous endoscopic gastrostomy (PEG) and percutaneous endoscopic jejunostomy (PEJ) comprise a mature technology that involves a minimally invasive gastrointestinal stoma that can improve patient quality of life and prognosis and has a significant clinical effect. The number of annual operations has reached 200,000-300,000 in the USA [1], so the clinical effect of this technique has been verified [2].

The indications [3, 4], contraindications [5-7], complications [8-10], clinical value, and quality of life improvements [11-13] of PEG/PEG. We started clinically applying this technology in 2003. Compared with the > 20 years of experience abroad, we have just a few years of experience and require further practice to select the appropriate indications for Chinese patients, reduce complications, and prolong patient life. Furthermore, the majority of domestic studies on PEG/PEJ to date compare enteral and parenteral nutrition, whereas studies comparing the clinical effects before and after PEG/PEJ in one person are lacking [1].

In our research, we use the percutaneous radiologic gastrojejunostomy (PRGJ) instead since the traditional PEJ technology has many disad-

Table 1. Nervous system diseases group (N=61)

	Albumin (g/L)	Prealbumin (mg/L)	Hemoglobin (g/L)	Hs-CRP (mg/L)	NLR	OPNI
Before atheter	31.00±6.83	146.00±65.89	112±14	15.75±18.92	4.06±1.2	32.3±4.3
After Catheter	36.43±6.74	187.87±64.86	116±15	3.39±2.92	3.42±4.2	43.2±6.6
t	-2.992	-4.196	-1.156	2.505	4.033	-3.14
P	0.006	0.154	0.257	0.037	0.001	0.007

Note: $P < 0.05$ had statistical significance.

Table 2. Digestive tract tumor group (N=26)

	Albumin (g/L)	Prealbumin (mg/L)	Hemoglobin (g/L)	Hs-CRP (mg/L)	NLR	OPNI
Before catheter	30.9±8.7	115.4±20	109.9±12.3	20.9±6.4	4.81±3.03	38.09±9.8
After Catheter	37.1±6.9	156.1±21	105.6±15.6	3.65±1.73	4.04±2.62	42.6±7.3
t	-5.504	-2.748	-2.068	1.993	1.902	-1.798
P	0.000	0.015	0.063	0.081	0.078	0.11

Note: $P < 0.05$ had statistical significance.

Table 3. Non digestive tract tumor group (N=10)

	Albumin (g/L)	Prealbumin (mg/L)	Hemoglobin (g/L)	Hs-CRP (mg/L)	NLR	OPNI
Before atheter	34.5±6.3	149±30.6	126.25±19.2	20.9±6.4	5.64±1.23	48.9±12.1
After Catheter	38.0±5.4	260±38.6	120.25±14.9	20.9±6.4	4.99±2.32	44.55±7.81
t	-1.147	-3.96	0.146	1.697	0.739	-0.471
P	0.303	0.017	0.889	0.339	0.501	0.662

Note: $P < 0.05$ had statistical significance.

Table 4. Other types of disease group (N=7)

	Albumin (g/L)	Prealbumin (mg/L)	Hemoglobin (g/L)	Hs-CRP (mg/L)	NLR	OPNI
Before atheter	30.25±6.1	151.75±26.4	96.4±10.3	4.58±1.02	8.91±2.08	40.96±8.2
After Catheter	35.67±7.65	151.75±26.4	112.2±13.0	2.23±1.73	5.75±1.76	52.58±6.36
t	-4.603	-4.801	-4.399	2.824	0.608	-4.024
P	0.044	0.041	0.022	0.106	0.605	0.057

Note: $P < 0.05$ had statistical significance.

vantages such as high surgical difficulty, long surgery duration, higher position of the jejunum tube, and tendency to shift, especially for patients who are elderly or have advanced cancer. In the above situations, it smooth implementation is difficult [14]. However, PRGJ successfully avoids the above shortcomings and has the following advantages: high surgical success rate, short surgery time, satisfactory catheter position, non-anesthesia, and no special discomfort [15]. According to the clinical experience of our hospital, here we summarize 104 cases of PEG/PRGJ performed in our hospital between 2003 and 2012 as well as discuss the clinical application and curative effect of PEG/PRGJ.

Materials and methods

General information

We summarized and analyzed 104 cases of PEG and/or PRGJ performed in our hospital between 2003 and 2012; 56 were men and 48 were women, and the mean age was 68.18±16.42 years. Nervous system diseases were present in 61 cases; digestive system tumors were seen in 26 cases; non-tumors of the digestive system were present in 10 cases; and other types of diseases were present in seven cases. The patients' data are shown in **Tables 1-4**. This study was conducted in accordance with the declaration of Helsinki. This

study was conducted with approval from the Ethics Committee of Peking Union Medical College Hospital. Written informed consent was obtained from all participants.

PEG/PRGJ placement method

For PEG placement [16], after the induction of intravenous anesthesia, the patient should remain in a supine position. We created a gastric fistula in the gastric cavity by puncturing the skin and perforated the stomach wall with the help of an endoscope.

For PRGJ placement [15], after PEG placement, the patient was subjected to X-ray fluoroscopy (without anesthesia). We then inserted a catheter and guide wire through the PEG. The pylorus, duodenum, and initial segment of the jejunum appeared with the aid of a contrast agent injected through the catheter. With help from the guide wire, the catheter was inserted into the upper jejunum, advanced approximately 30 cm, and then withdrawn. The jejunal tube was run along the guide wire, its proper position was confirmed, and the PEG and PEJ tubes were connected.

In each of the four groups, we examined the longest retained time (LTT), shortest retained time (STT), and average retained time (ATT) of the PEG/PRGJ tubes and compared the albumin, pre-albumin, high sensitivity C-reactive protein (Hs-CRP) levels, neutrophil-lymphocyte ratio (NLR), hemoglobin levels, and Onodera Prognostic Nutrition Index (OPNI) within 1 week before and 4 weeks after catheterization to evaluate the clinical efficacy of PEG/PRGJ.

Statistical methods

We analyzed the pre- and post-catheterization data in the four groups using a paired samples t-test with SPSS software to clarify the effects of PEG/PRGJ on nutrition, inflammation, and OPNI in the four groups.

Results

In the nervous system disease group, the LTT was 60.0 months, STT was 3.0 months, and ATT was 39.8±23 months. In the digestive tract tumor group, the LTT was 30.0 months, STT was 0.6 months, and ATT was 6.5±2.1 months. In the non-digestive tract tumor group, the LTT was 48.0 months, STT was 3.0 months, and ATT was 18.4±6.8 months. In the other types of disease group, the LTT was 48.0 months, STT was 24.0 months, and ATT was 29±1.3 months. The overall mean tube replacement time was 17.8 months in all patients versus 18.4 months for patients of the nervous system disease group. Of the 104 patients, buried bumper syndrome occurred in one (0.96%), the jejunum nutrition tube dropped into the digestive tract in two (1.9%), and a local wound infection occurred in 11 (10.5%). The overall complication rate was 13.4%.

Discussion

Enteral nutrition is the preferred clinical nutritional support therapy method. Establishment of the enteral nutrition pathway can be divided into nasogastric tube, nasojejunal tube, PEG/PEJ, and PEG/PRGJ [17]. Although its placement is simple, nasogastric tube feeding commonly causes reflux, aspiration, ulceration, bleeding, dislocation, and long-term clog intolerance and affects mood (causing irritation) and aesthetics, making it a suitable short- but not long-term solution [18-23].

Traditional gastrostomy/jejunostomy surgeries involve more trauma and more postoperative complications and are especially difficult to implement in elderly and weak patients. By comparison, PEG/PEJ/PRGJ procedures involve fewer surgical- and reflux-related complications, low aspiration rates, and easy postoperative maintenance. Patients experience minimal discomfort and aesthetic impacts. Most importantly, PEG/PEJ/PRGJ can be used long term to improve nutritional status, making it the ideal treatment choice for weak and elderly patients in need of long-term nutritional intervention [24-28].

The traditional placement method of PEJ is based on that of PEG, and we placed the jejunal feeding tube through the PEG tube and inserted the jejunum nutritional tube into the upper jejunum using biopsy forceps with the aid of a gastroscope. This technology has the following drawbacks: relatively high surgical difficulty, long surgical time, high catheter position, and high susceptibility to shifting. Patients, especially those who are elderly and frail, are commonly intolerant of the surgery. From the beginning of 2003, our hospital, according to our clinical practice experience, transformed PEJ

into PRGJ with the help of interventional radiology technology. As published elsewhere [15], PRGJ not only avoids risk and discomfort in endoscopic placement, it has the advantages of non-anesthesia, a high success rate, short operation time, and satisfactory catheter position. It is especially suitable for elderly and critical patients [16].

PEG/PRGJ indications have been shifted from nervous system disease combined with swallowing dysfunction to a series of eating disorders such as tumors complicated by digestive tract obstruction/eating disorders, short bowel syndrome, pancreatic pseudocyst with acute pancreatitis, esophagus cracks aperture hernia with severe reflux, and so on.

We studied and compared the nutritional index (albumin, pre-albumin, hemoglobin), inflammatory markers (Hs-CRP, NLR) and nutritional assessment and disease risk prediction index (OPNI) in the four groups of patients pre- and post-catheterization. To investigate the changes in inflammatory index and nutritional risk status with enteral nutrition treatment, this study introduced the NLR and OPNI. NLR is an index measuring system inflammation [28, 29]. Research shows that the gradual increase in lymphocytes and the gradual decrease in neutrophil counts occur with system inflammation. Meanwhile, patient prognosis is often good with a low NLR. More severe complications occur if the neutrophils increase and lymphocytes decrease continuously for 1 week [30].

OPNI, which is calculated as 5× albumin values (g/L) + lymphocyte count (109/L), is a prediction index of surgical risk and assessment tools of nutrition status based on nutrition and immune factors [31, 32]. It is simple, effective, and widely used in gastrointestinal surgery [31]. Referring to the standards formulated by Onokazu Temple, with an OPNI $\geq$ 45, good nutrition, and ability to tolerate the operation, prognosis is good; in contrast, with an OPNI < 45, poor nutrition, a high risk or inability to tolerate an operation, prognosis is poor [31].

The malnutrition risk rate of patients with nervous system diseases is as high as 36.6% [33]. We have reached a consensus on the question of nutrition support for diseases of the nervous system [34]. Nervous system diseases, such as disturbance of consciousness, mental disorders, cognitive disorders, neurogenic dysphagia, neurogenic vomiting, neurogenic gastrointestinal dysfunction, and neurogenic respiratory failure as well as the severe complications related to them are treated with short-term (2-3 weeks) enteral nutrition by nasogastric tube feeding or long-term PEG/PRGJ feeding. The 2005 ESPEN enteral nutrition guidelines reported that diseases of the nervous system have exceeded 50% among the PEG/PRGJ indications [18].

In this group, the patients with cerebral infarction, motor neuron disease, or senile dementia were tube fed until death (non-nutritional factors leading to death); during this period, their nutrition remained good. The PEG/PRGJ tubes were removed from the remaining patients after their illness was cured or in remission. In this group, a patient in a coma with viral encephalitis, whose tube retention time was the longest (60.0 months), had a weight increase of about 20 kg while the tube was in place, and we removed the tube after his illness entered remission. The average tube replacement time of 18.4 months was mainly attributed to the nursing care and discharge education provided at our hospital. This set of data showed significant differences in albumin, Hs-CRP, NLR, and OPNI, whereas the pre- and post-catheterization pre-albumin and hemoglobin levels did not differ significantly. This can be explained by the fact that the number of observations is too small and the patients' nutritional status had improved, not so dad.

Patients with advanced gastrointestinal cancer and digestive tract obstruction [26] may experience poor nutrition leading to multiple organ failure in a short amount of time if nutritional support is not administered in a timely fashion [35]. Nutritional support is one of the methods used to improve patient quality of life. The 2005 ESPEN enteral nutrition guideline found that, among patients with a PEG/PEJ, approximately 30% had a malignant tumor, a prevalence that was second only to nervous system disease (> 50%) [18]. In this group, 26 patients with digestive system neoplasms underwent PEG and/or PRGJ tube placement depending on the specific conditions. Patients with poor nutrition status commonly cannot tolerate surgery but can receive surgical intervention once it improves. Patients with advanced cancer who are not surgery candidates can get sufficient nutrition support and lay the foundation for other treatments [36-38].

In this group, of the seven patients with advanced gastric cancer and pyloric obstruction, three achieved surgical candidacy after their nutritional status improved. For patients with gastroparesis, in addition to providing nutritional support and gastrointestinal decompression, we can provide a digestion liquid transfusion by PEJ, reducing body fluid losses, maintaining water and electrolyte balance, and promoting gastric motility recovery. PEG/ PRGJ considers patient quality of life (appearance, no discomfort, no influence on respiration, and reduced regurgitation) and achieves good outcomes.

In this group, the average retained time was 6.5±2.1 months, and all patients kept their tubes until death. A patient who was diagnosed with a duodenal obstruction caused by duodenal lymphoma kept his tube for 30.0 months, the longest retained time in this group. This set of data showed significant differences in pre- versus post-catheterization albumin and prealbumin levels, which suggested that PEG/ PRGJ can improve the nutritional status and quality of life of patients with advanced cancer in the short term. However, we found no statistically significant difference in Hs-CRP, NLR, or OPNI, which can be explained by the following interfering factors: short observation time, advanced tumor stage, and tumor-related complications causing large energy consumption.

Incomplete intestinal obstruction caused by cancer is a common complication in patients with advanced malignant non-digestive system tumors [18]. Such tumors exist in the abdominal cavity, pelvic primary or metastatic malignant tumor in clinical, and ovarian cancer is seen more commonly (ovarian cancer invading the intestines accounts for 0.2-6.0% of gynecologic tumors) [39]. These patients are generally older, frail, and unable to tolerate the operation, radiotherapy, and chemotherapy. If nutrition is not provided in a timely manner, patients die rapidly of malnutrition and multiple organ failure caused by nutritional deficiency huge energy consumption of the tumor. Patient quality of life is extremely poor as well. Therefore, regardless of the medical or hospice viewpoint, nutritional support is a necessary treatment measure that can improve patient quality of life. Ten patients underwent PEG and/or PRGJ depending on their specific conditions. At the early stage, it can enable double decompression of the stomach and jejunum to alleviate the obstruction. At the later stage, it can provide enteral nutrition support treatment (low, uniform speed), improving patient prognosis and quality of life.

In this group, the LTT was 48.0 months, STT was 3.0 months, and ATT was 18.4±6.8 months. There were significant differences in pre-albumin level, whereas there were no statistically significant differences in albumin, Hs-CRP, NLR, hemoglobin, or OPNI, which are attributable to very-late-stage cancer, insufficient survival time, insufficient treatment time, and too few cases.

Regarding other applications of PEG/PRGJ, two patients who were diagnosed with short bowel syndrome underwent PEG placement, which we then converted to PRGJ under X-ray guidance. Short bowel rehabilitation therapy after operation is started at a low speed, low concentration, and low capacity and the tolerance of enteral nutrition is gradually increased. During this time, supplemental parenteral nutrition was also provided. The patients ingested small amounts of a liquid oral diet daily. At the same time, the nutrition agent, consisting of short peptides, was pumped into the digestive tract continuously at a low speed via the jejunum nutrition tube. To reduce gastrointestinal irritation and avoid diarrhea, enteral nutrition can be heated (37-38°C) and diluted, then pumped into the digestive tract at 15 mL/h. We can then gradually increase the concentrations (osmotic pressure, 340 mOsm/L), speed (30 mL/h), and temperature (room temperature) according to each patient's tolerance. Given that the small intestine in short bowel patients is too short (< 50 cm), their compensatory ability is limited, and enteral nutrition alone cannot meet the energy demand, we can supplement parenteral nutrition daily through a peripherally inserted central catheter to gradually improve their nutrition index [40, 41].

In this group, three patients with pancreatic pseudocyst and acute pancreatitis combined with upper gastrointestinal tract obstruction underwent PEG/PRGJ placement. After 24 h, we administered a small amount (250 mL) of a short peptide and free amino acid type nutrition agent and gradually transitioned to a full volume, total protein nutrition agent. Apart

from ensuring the supply of nutrients, the pumping of full, balanced enteral nutrition directly into the jejunum skips the pancreas to reduce the pancreatic secretions allow the pancreas to rest.

Special nutrients in enteral nutrition, such as glutamine, arginine, 2-fatty acids, and dietary fiber, can effectively relieve the ischemic reperfusion injury, promote a positive nitrogen balance, enhance immune cells and intestinal mucosal barrier function, and reduce the intestinal bacteria and endotoxin translocation [42], helping patients through the acute period of pancreatitis stably and safely as well as ensuring gradual absorption and reduction of the cyst and avoiding surgical treatment. The use of an enteral nutrition tube not only can avoid surgical trauma in the acute phase, it can avoid the side effects of parenteral nutrition. The tube retaining time in these three cases was 1.5, 3, and 3 months, and the prognosis was good.

Two patients diagnosed with esophagus cracks aperture hernia with severe reflux combined with feeding difficulty and severe pulmonary infection caused by aspiration. After PEG/PRGJ placement, apart from ensuring the supply of nutrients, this tube can efficiently facilitate gastric decompression, greatly reduce reflux and aspiration, and improve and cure pulmonary infection. At the same time, PRGJ can also be used for gastric recharge, reducing body fluid losses, and ensuring water-electrolyte balance. Compared with the traditional nasogastric tube, this tube greatly reduces discomfort and improves quality of life. The retaining tube time of one case was 7 years (placed in 2008; mean tube replacement time, 12 months; the patient keep this tube until now without complications) with a good general condition.

Early complications of PEG/PRGJ include puncture site infection (most common), pneumoperitoneum, gastric juice overflow, and others. Long-term complications include lumen blocking, fracture, stomach content overflow, puncture site cellulitis, eczema, and entrapment syndrome. Among them, entrapment syndrome is a rare complication; once it occurs, we must re-catheterize, but this can be avoided by correct aftercare. According to the ESPEN guidelines, the complications rate after endoscopic placement of enteral feeding tubes is estimated to be in the range of 8-30% depending on the very different definitions of what actually constitutes a complication. Serious complications requiring treatment occur in approximately 1-4% of cases. Acute and severe complications such as perforation, serious abdominal hemorrhage, or peritonitis, all of which require surgical intervention, occur in far fewer than 0.5% of cases in which the abovementioned contraindications are observed [2, 18]. Among the 104 patients in this study, entrapment syndrome was diagnosed in one (0.96%), a jejunum tube entered the digestive tract in two (1.9%), and a wound infection occurred in 11 (10.5%). The overall complication rate was 13.4%, consistent with the guidelines.

The above data show that PEG/PRGJ is safe, convenient, and a reasonable way to treat the above diseases; additionally, it can improve nutritional status and quality of life. As such, with the gradual adoption of PEG/PRGJ in the clinical setting, its indications are gradually expanding and its treatment effect is good.

Conclusion

In the short term, for patients with nervous system diseases, PEG/PRGJ can improve the nutrition index (albumin), reduce inflammation (CRP, NLR), and improve the OPNI and life quality. For patients with digestive tract or non-digestive tract tumors, PEG/PRGJ can improve the nutrition index (pre-albumin) and life quality. For patients with other types of disease, PEG/PRGJ can improve the nutrition index (albumin, prealbumin, hemoglobin) and life quality. Diseases of the nervous system, advanced tumor causing obstruction of digestive tract, or eating difficulties and some special types of diseases in a certain period, such as short bowel syndrome, pancreatic pseudocyst with acute pancreatitis, and esophagus cracks aperture hernia with severe reflux, can all be its indications.

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Disclosure of conflict of interest

None.

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