Percutaneous Endoscopic Jejunostomy and Jejunal Extension Tube through Percutaneous Endoscopic Gastrostomy: A Retrospective Analysis of Success, Complications and Outcome

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Key Words

Percutaneous endoscopic jejunostomy • Jejunal access through percutaneous endoscopic gastrostomy • Nutrition • Complication, risk factors

Abstract

Background: Percutaneous access to the jejunum is an important approach if gastrostomy feeding is not possible. **Objective:** To analyze success, short- and long-term complications (STCs, LTCs) in patients with percutaneous endoscopic jejunostomy (PEJ) and jejunal access through percutaneous endoscopic gastrostomy (Jet-PEG). **Methods:** A retrospective analysis of endoscopically placed PEJs and Jet-PEGs. Success rates, mortality, STCs and LTCs were investigated for risk factors comprising demographic data, underlying disease, previous surgery and experience of the endoscopist. **Results:** 205 PEJ and 58 Jet-PEG placements were included in the study. PEJs and Jet-PEGs were successfully placed in 65.4 and 89.7%, respectively. Billroth II surgery predisposed in favor of a significantly higher success rate for PEJ placement ($p = 0.014$, OR = 2.27). Inexperienced examiners have a significantly ($p = 0.040$) lower success rate for tube insertion than examiners with a medium level of experience. STCs and LTCs occurred evenly in PEJ and Jet-PEG patients. Dislocation of the tube occurred significantly more frequently in Jet-PEG patients (33.3%, $p = 0.005$). Aspiration was most

common for bedridden patients. **Conclusion:** PEJ has a significantly lower success rate for insertions, but fewer LTCs. The experience of the endoscopist correlates with the success rate of tube insertion.

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Introduction

Enteral feeding via a percutaneous approach – most often applied through endoscopy – is a mainstay in the therapy of patients unable to meet their nutritional needs. Gastrostomy feeding is now the second most common indication for esophagogastrroduodenoscopy in the USA [1]. Sometimes, however, a jejunal route is necessary either for functional (such as gastroparesis) or morphological (stenosis, previous esophageal or gastric surgery) reasons. Jejunal access using a jejunal tube through a percutaneous endoscopic gastrostomy (PEG) was first described by Ponsky and Aszodi [2] in 1984. This method is now most commonly referred to as jejunal extension tube through PEG (Jet-PEG). In 1987, Shike et al. [3] reported the successful placement of a feeding tube by direct puncture of the jejunum similar to the conventional pull-through PEG technique.

Despite its description more than 20 years ago, published experience with Jet-PEGs and percutaneous endo-

scopic jejunostomies (PEJs) is rather sparse. Additionally, most papers report on rather small numbers of investigated procedures that further limit their scientific yield [4–7]. While most authors reported on success rates which appear to be markedly lower than in PEG placement [8–10], short- and long-term complications are widely unknown and studies comparing PEJs and Jet-PEGs, which may be used alternatively, are almost completely lacking. Additionally, each procedure may exhibit specific advantages and drawbacks. For example, the jejunal extension tube of Jet-PEGs may be prone to dysfunction and proximal migration into the stomach, which may in turn lead to aspiration. In contrast, the insertion of PEJs is said to be technically more difficult and therefore associated with higher complication rates than the insertion of a Jet-PEG.

Therefore, we performed a retrospective analysis of the register of our nutritional support team investigating success rates, short- and long-term complications and their contributing factors in PEJ and Jet-PEG placement.

Methods

All patients who underwent placement of PEJ or Jet-PEG (either by primary puncture or by an existing percutaneous access) at the Department of Medicine I, University Hospital Erlangen from 1991 until 2003 were included in the analysis. A total of 205 PEJ and 58 Jet-PEG placements were identified in the register of the nutritional support team or the endoscopy unit of the department.

Hospital and outpatient charts were reviewed for all patients undergoing placement of PEJ or Jet-PEG. Questionnaires and phone calls with referring physicians, family, and nursing home personnel were also carried out in case of missing information. The following parameters were assessed: demographic data including underlying disease, body mass index, laboratory, nutritional parameters, indication for the procedure, technical success of the procedure, experience of the endoscopist in placing feeding tubes (total experience as the main endoscopist and as an assistant: inexperienced, ≤ 66 endoscopies; medium level of experience, 67–187 endoscopies; experienced, >188 endoscopies), short- and long-term complications (within 7 days after placement or after) such as local infection or pain, but also diarrhea and patients' outcome. End points were stipulated upon death, removal of the tube or end of the observation period.

Patients in the PEJ group received a 9F direct jejunostomy tube; a 15F PEG tube with a 9F jejunal extension was used in the Jet-PEG group. All tube insertions were performed using the pull technique. Antibiotic prophylaxis was administered in patients with a high risk of developing wound infection or in patients who were already receiving antibiotics for other reasons. Procedures were routinely performed in the endoscopy unit after standard upper endoscopy, using topical anesthetic (1% scandicain), intravenous midazolam (2.5–5 mg) and pethidin (50–100 mg). Tube feeding was usually initiated within 6–24 h.

The follow-up was categorized in short-term (within 7 days) and long-term complications (up to 4 years after tube insertion). Long-term complications included stomal complications, tube complications and nutritional complications.

Statistical Analysis

The χ^2 test or Fisher's exact test were used to compare categorical variables. A logistic regression analysis was performed to obtain estimates of the odds ratio and to be able to adjust for confounding factors. To be able to assess the examiner's experience, a model of success rates was created by means of a generalized (logistic) mixed effects model in which the examiner is included as random effect. Experience, type of tube and other covariates are assumed to be fixed. Survival rates are estimated using the Kaplan-Meier estimator.

Hazard rates were conducted to reproduce the follow-up of the feeding and stomal complications from the time of feeding tube insertion.

A p value of ≥ 0.05 was considered significant. The computations were performed using the R system for statistical computing [11].

Results

Patients' characteristics including demographic data, underlying diseases, clinical status and application of antibiotic prophylaxis are shown in table 1.

Jejunal access was applied because of functional (30% gastroparesis) and morphological (15% stenosis of the upper gastrointestinal tract, 51% postoperative status) disorders. In 4% of the patients, miscellaneous indications were documented (e.g. thoracic stomach, absences of gastric diaphania, etc.).

Altogether, 205 and 58 patients were designated for PEJ and Jet-PEG placements, respectively. The overall success rate for PEJ was 65.4% ($n = 134$) and for Jet-PEG 89.7% ($n = 52$; $p < 0.0001$). In case of failure of tube insertion, a second or multiple attempts were made for successful tube insertion (table 2).

The observation period was 101.5 ± 236.2 days on average. The durability of the tubes was 231.8 ± 375.2 days altogether, on average 272.0 ± 414.2 days in PEJ and 129.8 ± 223.3 days SD in Jet-PEG patients. End points of the study were indicated by the removal of the tube. Specific indications for removal are given in table 3. Death was caused by an underlying malignant tumor in 51.7% ($n = 136$), apoplexy in 6.5% ($n = 17$), infection in 1.9% ($n = 5$), coronary heart disease in 6.1% ($n = 16$), aspiration pneumonia in 3.0% ($n = 8$), sepsis in 1.9% ($n = 5$), and underlying diseases in 28.9% ($n = 76$) of the patients. None of the patients died because of the jejunal access.

Table 1. Patients' characteristics

	PEJ	Jet-PEG	Total
Number of placement trials	205	58	263
Age, years	67.1 ± 11.9	63.5 ± 16.7	n.s.
Male sex, n	160 (78.0%)	33 (56.9%)	p = 0.002
Clinical status			
Hyperlipidemia, n	33 (18.8%)	19 (42.2%)	52 (23.5%)
Hypertension, n	93 (47.4%)	33 (61.1%)	126 (50.4%)
Diabetes mellitus, n	87 (45.1%)	33 (61.1%)	120 (48.6%)
Renal insufficiency, n	39 (20.0%)	18 (34.6%)	57 (23.1%)
Bedridden, n	86 (43.2%)	42 (76.4%)	128 (50.4%)
Antibiotic prophylaxis, n	109 (57.4%)	43 (78.2%)	152 (62.0%)
BMI at insertion time	20.5 ± 3.8	22.2 ± 5.1	p = 0.045
Underlying disease			
Malignancy, n	139 (67.8%)	9 (15.5%)	148 (56.3%)
Neurological disease, n	55 (26.8%)	40 (69%)	95 (36.1%)
Malignancy and neurology, n	4 (2%)	4 (6.9%)	8 (3.0%)
Other, n	7 (3.4%)	5 (8.6%)	12 (4.6%)
Previous GI surgery			
Esophagectomy, n	14 (6.9%)	0 (0%)	14 (5.5%)
Billroth I gastric resection, n	11 (5.4%)	0 (0%)	11 (4.3%)
Billroth II gastric resection, n	76 (37.6%)	1 (1.9%)	77 (30.2%)
Total gastrectomy, n	30 (14.9%)	0 (0%)	30 (11.8%)
Whipple operation, n	14 (6.9%)	0 (0%)	14 (5.5%)

Table 2. Success rates for percutaneous access through PEJ and Jet-PEG placements

	PEJ	Jet-PEG
Successful placements, n	134 (65.4%)	52 (89.7%)
1 attempt, n	105 (51.2%)	34 (58.6%)
2 attempts, n	20 (20.0%)	15 (62.5%)
3 or more attempts, n	9 (11.3%)	3 (33.3%)

Short- and long-term stomal complications and nutritional complications in patients with PEJ and Jet-PEG occurred almost at the same rate. Long-term tube complications were found more often in patients with Jet-PEG. All complications are adjusted for the underlying diseases mentioned in table 1. A detailed overview of long-term stomal, long-term tube and feeding complications is given in table 4.

Follow-Up of Long-Term Stomal and Enteral Nutritional Complications up to 12 Months

For long-term stomal and enteral nutritional complications, hazard rates were computed to assess how the rate of complications behaves over a period of time. It can

be seen that the hazard rate is strictly decreasing within the first year and is negligible after this time period. So, the risk of experiencing a complication is highest in the initial phase after tube insertion.

Success Rate

Statistical testing did not detect any effect for age, gender and disease on the success rate for tube placements. The opposite result, however, was found for the influence of postoperative status. Patients with Billroth II resection showed a higher success rate. However, these patients received the PEJ tube significantly more often, with primary success rates being lower than Jet-PEGs, so the effect might even be stronger. Consequently, in a mixed model (adjusted for the examiner's random effect) the effect is significant (OR = 2.27, p = 0.014) and becomes even stronger when adjusted for the type of tube (OR = 3.45, p < 0.001).

Examiner's Experience

Examiners were categorized into 3 groups of experience in endoscopic tube placements: inexperienced examiners (≤66 endoscopies), examiners with a medium level of experience (67–187 endoscopies) and experienced examiners (≥188 endoscopies). Examiners succeeded in 63.7, 77.5, and 74.2%, respectively, for the above-mentioned categories.

Table 3. Indications for tube removal and average durability of tube

Reasons for removal	PEJ	Jet-PEG	p value
Death	83 (61.9%)	25 (48.1%)	n.s.
Infection	13 (9.7%)	–	0.041
Dislocation	2 (1.5%)	11 (21.2%)	<0.0001
Resumed oral intake	10 (7.5%)	4 (7.7%)	n.s.
Tube defect	8 (6.0%)	1 (1.9%)	n.s.
Obstruction	2 (1.5%)	6 (11.5%)	0.010
No removal	4 (3.0%)	2 (3.8%)	n.s.
Other (e.g. mistake of homecare)	9 (6.7%)	2 (3.8%)	n.s.
Average duration of tube, days	272 ± 414	130 ± 223	0.023

Comparing examiners with a medium and a high level of experience to inexperienced examiners in a mixed model according to their success rate, a significant difference can be found between examiners with a medium and a low level of experience ($p = 0.040$).

Mortality

The Kaplan-Meier method was used to estimate the overall mortality rate within time periods of 7 and 30 days, and 1 and 3 years with the results amounting to 5.4, 21.0, 62.4, and 72.4%, respectively. Mortality broken down for the distinctive tube was as follows: PEJ 3.7, 18.7, 62.7, and 72.6%, and for Jet-PEG 9.6, 26.9, 61.5, 72.2%, showing no significant differences.

Discussion

In this retrospective study of PEJ and Jet-PEG placements, we were able to show that the success rate of PEJ placement depends on previous surgery (Billroth II) and the experience of the examiners. Adjusted for the underlying diseases, tube-associated complications occur significantly more often in Jet-PEG patients, whereas stomal and nutritional complications are almost identical between PEJ and Jet-PEG patients. Within 12 months, however, the risk of complications shows a definite downward trend.

In our investigation of 263 patients, our success rates in PEJ and Jet-PEG of 65.4 and 89.7%, respectively, are comparable with those reported in the published literature [5, 12]. A recent review of direct PEJ placement even

Table 4. Short-term stomal, long-term stomal, long-term tube and nutritional complications in patients with PEJ and Jet-PEG

	PEJ, %	Jet-PEG, %	p value
Short-term stomal complications			
Infection	20.6	0.0	0.093
Erythema	42.1	31.9	0.298
Bleeding	9.5	4.3	0.356
Pain	27.8	17.0	0.208
Secretion	34.6	12.8	0.145
Long-term stomal complications			
Infection	38.7	10.3	0.0140
Erythema	53.2	44.8	0.555
Bleeding	6.3	10.3	0.432
Pain	18.0	0.0	0.120
Secretion	48.7	24.1	0.031
Ingrowth	10.8	0.0	0.202
Abscess	9.9	3.5	0.460
Long-term tube complications			
Clotting	9.9	40.0	0.002
Dislocation	5.4	33.3	0.005
Tube defect	15.3	16.7	0.918
Aspiration	18.1	31.0	0.050
Nutritional complications			
Fatigue	23.4	3.6	0.432
Intolerance of enteral feeding	6.3	3.6	1.000
Constipation	18.0	7.1	0.246
Nausea	25.2	21.4	0.864
Vomiting	27.9	46.4	0.098
Diarrhea	51.4	46.4	0.799

p values are adjusted for the underlying diseases.

found an overall success rate of 72%, although the rate of 64% was lower in patients without prior abdominal surgery (i.e. gastrojejunostomy, esophageal resection, gastrectomy) [8] – a finding that is supported by our data. By means of a multiple regression model we were able to determine that a Billroth II postoperative status facilitates the intervention. Billroth-II resections probably appear to be advantageous because most surgeons position the jejunum ventrally to the transverse colon, thus making translumination and puncture of the jejunum easy. Furthermore, according to other studies investigating the impact of the experience of endoscopists, we were able to show that inexperienced examiners have a lower success rate. Several clinical trials in endoscopy have shown that experience in terms of numbers and frequency of endoscopic interventions determines the clinical outcome such as ERCP [13], sphincterotomy [14], or application of hemoclips [15] – all appear to share this observation. Ad-

ditionally, we were able to show that even in the case of an unsuccessful puncture a second approach is worthwhile, producing similar success rates of up to 60%.

The short- and long-term stomal infection rates for PEJ amounted to 20.6 and 38.7% and was significantly higher than for Jet-PEG, which behaves like a PEG placement in this context [16]. Our finding complies with DiSario [17] and Patterson [18], who found stomal wound infection rates in PEJ placements of 15 and 20%, respectively. However, adjusted for the underlying disease we could no longer see a significant difference in the occurrence between both tubes. This indicates the impact of the underlying diseases.

Reported data regarding rates of aspiration show great variation. DiSario et al. [17] found the incidence of aspiration to be as high as 60%, whereas Patterson et al. [18] reported no episode. Kaplan et al. [19] and Wolfsen et al. [20] found the incidence of aspiration in their series to be 13 and 17%, respectively. In our study, we determined aspiration in 18% of PEJ and in 31% of Jet-PEG patients. The rate of aspiration in Jet-PEG patients is probably due to the higher dislocation and migration of the jejunal tube in the stomach. Nevertheless, the aspiration rate in PEJ patients with 18% is still alarmingly high. This could be due to aspiration of their own oropharyngeal secretion [21] or to an increased gastric secretion by jejunal feeding [22]. However, adjusting for bedridden patients, no differences in the occurrence of aspiration could be found between both tubes. Regardless of the tube placed, this fact could indicate the generally rising risk in patients who mainly lie in a horizontal position and thus harbor the risk of aspiration.

The high rate of Jet-PEG tube dislocation in the present study was similar to that in other studies. Wolfsen et al. [20] actually encountered Jet-PEG tube dislocation in 53%. The reason can probably be found in the position of the gastric stoma: if it is directed cranially, the jejunal tube produces an intragastric loop which is predisposed to dislocation; in case of a stoma directed towards the pylorus, the jejunal tube usually is placed in a stable position. Another possible explanation for proximal migration in the present study may be the high flexibility of the 9F jejunal tube. Larger caliber tubes may be stiffer and, therefore, less prone to proximal migration.

The overall 30-day mortality of our population is in line with DiSario et al. [17]. The 7- and 30-day mortality rates for PEJ were higher than in patients with Jet-PEG. Although the underlying disease was mainly responsible for mortality, the indication for tube insertion should be decided carefully, considering the fact that complication rates significantly exceed those of PEG placement.

Conclusion

Jejunostomy, either by direct puncture or jejunal extension of a PEG, is characterized by success rates of 65–89%, and stomal and nutritional complications which mostly subside within a few months. The experience of the endoscopist plays a crucial role in the success rates. For direct puncture, the presence of a Billroth II resection increases the probability of a successful outcome. Aspiration is most common in bedridden patients, which indicates that these patients should be monitored closely.

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