

# Feeding Duodenostomy Decreases the Incidence of Mechanical Obstruction After Radical Esophageal Cancer Surgery

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## Abstract

**Background** Nutritional support influences the outcome of gastroenterological surgery, and enteral nutrition effectively mitigates postoperative complications in highly invasive surgery such as resection of esophageal cancer. However, feeding via jejunostomy can cause complications including mechanical obstruction, which could be life threatening. From 2009, we began enteral feeding via duodenostomy to reduce the likelihood of complications. In this study, we compared duodenostomy with the conventional jejunostomy feeding, mainly looking at the catheter-related complications.

**Methods** The database records of 378 patients with esophageal cancer who underwent radical esophagectomy with retrosternal or posterior mediastinal gastric tube reconstruction in our department from January 1998 to December 2012 were examined. Of the 378 patients, 111 underwent feeding via duodenostomy (FD) and 267 underwent feeding via jejunostomy (FJ), and their records were reviewed for the following catheter-related complications: site infection, dislodgement, peritonitis, and mechanical obstruction.

**Results** Mechanical obstruction occurred in 12 patients in the FJ group but none in the FD group (4.5 % vs. 0 %,  $P = 0.023$ ). Of the 12 cases, 7 (58.3 %) required surgery of which 2 had bowel resection due to strangulated mechanical obstruction. Catheter site infection was seen in 14 cases in the FJ group, of which 2 (14.2 %) had peritonitis following catheter dislocation, while only one case of site infection was seen in the FD group (5.2 % vs. 0.9 %,  $P = 0.078$ ).

**Conclusions** Feeding via duodenostomy could be the procedure of choice since neither mechanical obstruction nor relaparotomy was seen during enteral feeding through this technique.

## Introduction

In gastrointestinal surgery, jejunostomy is used for nutritional management after highly invasive surgeries where a long

period of eating difficulty is expected [1–3]. This is particularly important for patients with esophageal cancer who often suffer from poor nutritional intake due to hypophagia resulting from esophageal stenosis or preoperative chemotherapy. Early enteral nutrition using a feeding jejunostomy is beneficial in the perioperative management of esophageal cancer to reduce the duration of ICU treatment and to enhance recovery of the immune system [1, 4]. Because of its benefit, enteral feeding via jejunostomy is administered from the early postoperative period for all patients with esophageal cancer who underwent radical esophageal resection in the Department of Gastroenterological Surgery (Surgery II) at

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Nagoya University Hospital. Although the merits of enteral nutrition are clear, feeding via jejunostomy catheter is considered suboptimal because of its associated complications, such as mechanical obstruction and catheter-related peritonitis caused by leakage of digestive fluids at tube insertion sites [5–7]. Mechanical obstruction is particularly problematic because it can lead to relaparotomy and malnutrition. Despite various modifications in the ways the catheter was inserted or fixed, we were unable to reduce the incidence of mechanical obstruction. Since 2009, we employed catheter feeding via duodenostomy for its potential benefit in reducing the catheter-related complications. In the current study, we made a comparison between the duodenostomy and jejunostomy, particularly focusing on catheter-related complications including mechanical obstruction.

## Materials and methods

### Patients

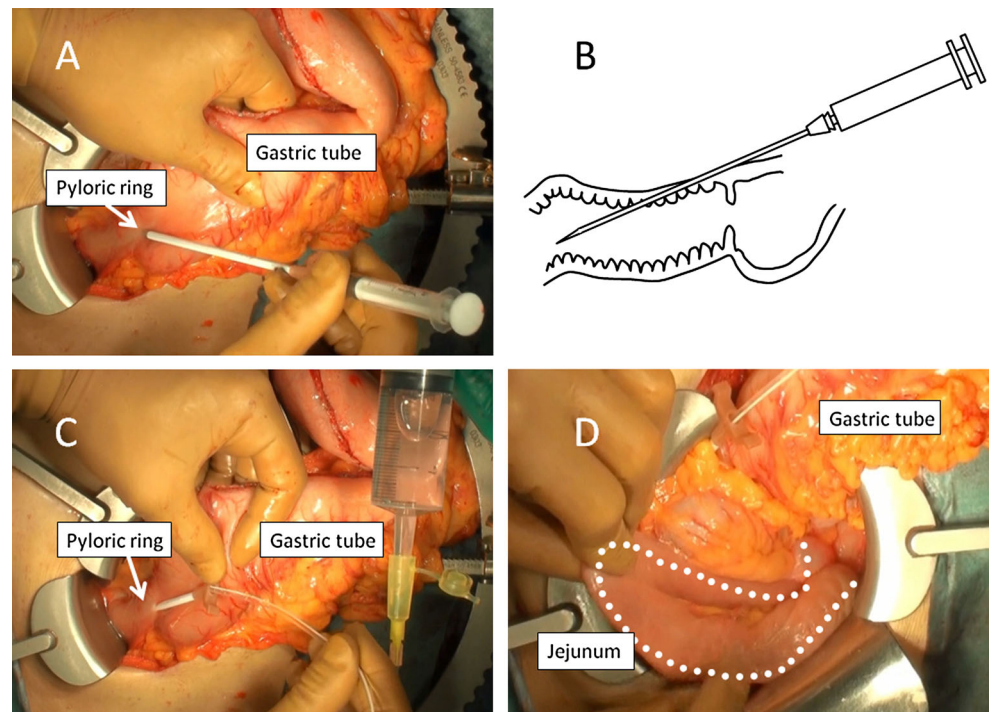
A total of 378 patients with esophageal cancer underwent radical esophageal cancer surgery and retrosternal or posterior mediastinal gastric tube reconstruction from January 1998 to December 2012 in the Department of Gastroenterological Surgery (Surgery II), Nagoya University Hospital. Of the 378 patients, 111 had feeding via duodenostomy (FD) and 267 had feeding via jejunostomy (FJ). FJ was performed exclusively during the period from

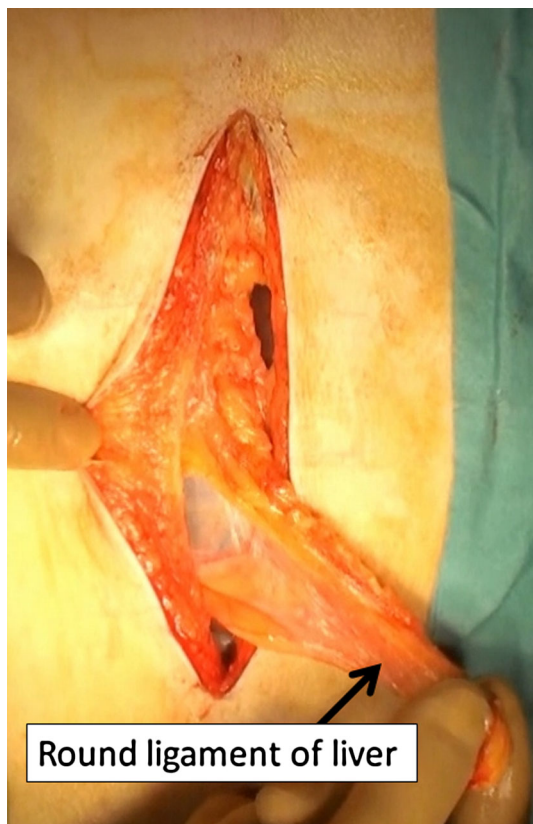
1998 to 2009, while FD was employed after 2009. The records of all patients were reviewed and the following catheter-related complications were analyzed: catheter site infection, dislodgement, catheter-related peritonitis, and mechanical obstruction. In both groups, abdominal manipulation was done via a median epigastric incision, gastric tubes were created using mechanical stapling devices, pyloroplasties were performed manually, and 9-Fr silicon catheters (Kangaroo™ Covidien Japan, Tokyo, Japan) were placed via jejunostomy or duodenostomy following the instruction manual.

### Indwelling catheter in the duodenum

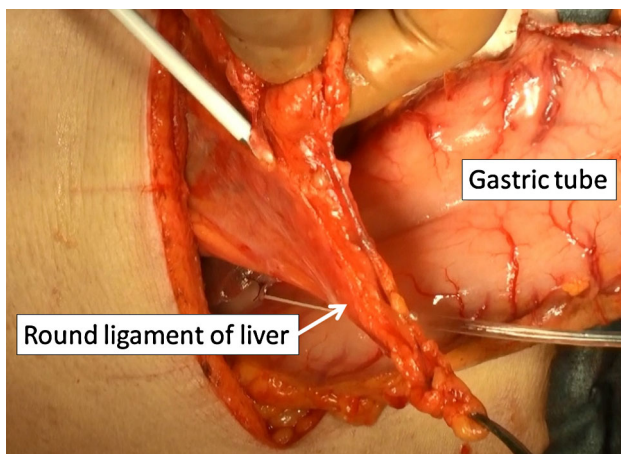
The plastic cannula needle in the introducer kit was passed from the pyloric ring to the duodenal bulb (Fig. 1a, b) and a feeding tube was placed. While injecting 0.9 % saline into the duodenum through the catheter (Fig. 1c), we inserted the catheter approximately 40 cm to a position beyond the ligament of Treitz (Fig. 1d) and fixed the catheter with a purse string suture at the point where the tube penetrated through the duodenal wall. The round ligament of the liver and the surrounding adipose tissue was ligated just above the umbilical region and mobilized from abdominal wall (Fig. 2), which was punctured with the plastic cannula needle (Fig. 3), through which the catheter was guided. The end of the adipose tissue was fixed with four sutures to the puncture site at the duodenum (Fig. 4) so that the catheter could be guided from the abdominal wall into the

**Fig. 1** **a** Plastic cannula needle was inserted from pyloric ring to duodenal bulb. **b** Schematic view of insertion of cannula needle. **c** The feeding tube was inserted while injecting 0.9 % saline into the duodenum. **d** The catheter was inserted to a position beyond the ligament of Treitz. The *white dotted line* represents the course of the catheter





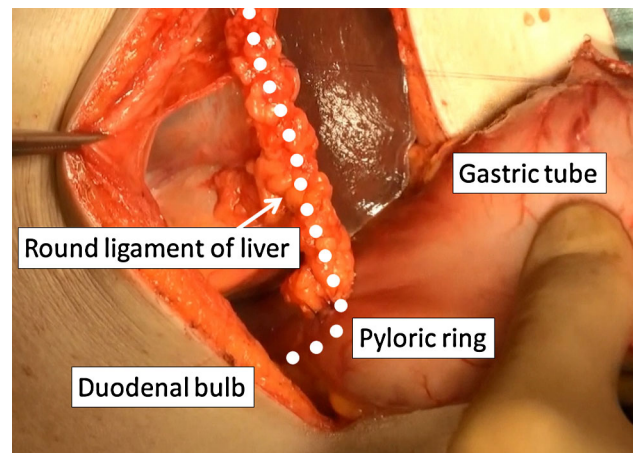
**Fig. 2** Mobilized round ligament of the liver and the surrounding adipose tissue



**Fig. 3** Punctured adipose tissue with the plastic cannula needle

duodenum covered fully with adipose tissue. The catheter was eventually guided through the median epigastric incision and fixed to the skin surface.

In the FD group, patients were scheduled for preoperative counseling during which their nutritional status was



**Fig. 4** Sutured adipose tissue to the tube implantation site. White dotted line represents the course of the catheter

evaluated. In the event that the patient was rated undernourished, carbohydrate-enriched diet or enteral tube nutrition was administered preoperatively as indicated. After surgery, enteral feeding was started on postoperative day (POD) 2, using a continuous 24-h infusion of ingestion of immunoenhancing enteral nutrients “Anom” (Otsuka Pharmaceutical Factory, Inc, Tokyo, Japan), beginning with 500 ml/day on postoperative day 2 and progressing to the maximum volume of 1600 ml/day by POD 5, paying attention to occurrence of diarrhea. Intravenous infusion is usually given at 80 ml/h and is gradually decreased as the enteral feeding increases until the venous catheter was removed on POD 5. Oral food intake was basically allowed on POD7. Although the amount of enteral feeding was meticulously controlled and was decreased as the amount of oral food intake increased, enteral feeding was to be continued at home until the oral intake stabilized and was considered to be sufficient at around 1–2 months after being discharged from the hospital.

#### Indwelling catheter in the jejunum

The feeding catheter was fed into the jejunum, and the catheter tip was advanced a further 30 cm and fixed with a purse string suture. The catheter was guided outside the body through the abdominal wall at the upper left side of the umbilicus. Four interrupted sutures were placed to attach the jejunum to the abdominal wall for a length of 10 cm.

Nutritional support and fluid management during the perioperative phase had not been standardized. After surgery, patients were generally given a total of 1.5–2 l of fluids in the form of either the enteral nutrients or as intravenous fluid administration (Ringer’s lactate) until

they had adequate oral fluid intake which was defined as intake without the need for additional fluids. Furthermore, intake was increased step by step and started with a clear liquid diet which was expanded to a normal diet over the course of a couple of days. Oral food intake was also basically allowed on POD 7. Time point for removal of the enteral feeding tube had not been predetermined and, again, depended on the amount of oral food intake.

#### Statistical analysis

Prospectively collected data in a computerized database were examined in the present study. Additional data were obtained by reviewing the medical records. Patient demographic data, incidence of complications that could lead to relaparotomy including mechanical obstruction, catheter site infection, catheter-related peritonitis, and catheter dislodgement caused by the indwelling catheter, incidence of other complications, length of stay, and 30-day and in-hospital mortality were examined in each group. Clinical staging of tumors was performed according to the tumor-node-metastasis (TNM) classification system [8]. All analyses were performed using SPSS II software (IBM Institute, Armonk, NC, USA). A *P* value less than 0.05 was considered significant. All continuous variables are presented as mean  $\pm$  standard deviation. Data were compared statistically using the  $\chi^2$  test or Fisher's exact test to evaluate differences between qualitative variables.

## Results

Patient and tumor characteristics are listed in Table 1. The mean age of patients in the FD group ( $65.18 \pm 7.60$  years) was higher than those in the FJ group ( $61.93 \pm 7.91$  years). Compared to the FJ group (40 %), more patients had received preoperative adjuvant therapy in the FD group (66 %).

The incidence of mechanical obstruction was significantly lower in the FD group (0 cases) compared with that in the FJ group (12 cases, 4.5 %) ( $P = 0.023$ ). The mean interval from esophageal resection to the development of mechanical obstruction was  $43.85 \pm 33.77$  days (range, 16–102 days). Decompression tube was inserted in all 10 cases for whom emergency surgery was not indicated. The mean duration of conservative therapy by decompression was  $10.78 \pm 3.38$  days (range, 1–14 days). Surgery was eventually needed in 7 of the 12 cases (58.3 %) since bowel obstruction did not resolve by decompression. Five of the seven patients underwent adheolysis of the jejunostomy and the others had strangulated bowel that required enterectomy. One of the two

**Table 1** Patient and tumor characteristics

	Feeding duodenostomy		Feeding jejunostomy		<i>P</i> value
	<i>n</i> = 111	(%)	<i>n</i> = 267	(%)	
Sex					0.855
Male	90	(81)	214	(80)	
Female	21	(19)	53	(20)	
Age (years old)					<0.001
Mean $\pm$ SD	$65.18 \pm 7.60$		$61.93 \pm 7.91$		
Range	40–83		32–80		
Tumor site					0.166
Ce	115	(1)	10	(4)	
Ut	15	(13)	31	(12)	
Mt	60	(54)	132	(49)	
Lt	34	(31)	80	(30)	
Ae	1	(1)	14	(5)	
TNM stage [6]					0.938
I	24	(22)	52	(19)	
IIA, B	31	(28)	71	(27)	
III	40	(36)	103	(39)	
IVA, B	16	(14)	41	(15)	
Neoadjuvant therapy					<0.001
Yes	73	(66)	108	(40)	
No	38	(34)	159	(60)	

*Ce* cervical esophagus, *Ut* upper thoracic esophagus, *Mt* middle thoracic esophagus, *Lt* lower thoracic esophagus, *Ae* abdominal esophagus

cases that needed enterectomy required extensive enterectomy of more than 2 meters in length. The incidence of catheter site infection tended to be lower in the FD group (1 case, 0.9 %) than in the FJ group (14 cases, 5.2 %) ( $P = 0.078$ ). Two of the 14 catheter site infections (14.2 %) in the FJ group developed into peritonitis following catheter dislocation. There was only one case (0.9 %) of catheter site infection in the FD group, which did not progress to peritonitis.

Other postoperative complications occurred included 16 cases (5.9 %) of pneumonia, 19 cases (7.1 %) of recurrent nerve paralysis, and 19 cases (7.1 %) of leakage in the FJ group and 7 cases (6.3 %) of pneumonia, 3 cases (2.7 %) of recurrent nerve paralysis, and one case (1.0 %) of leakage in the FD group (pneumonia;  $P = 0.907$ , recurrent nerve paralysis;  $P = 0.095$ , and leakage;  $P = 0.014$ ). The mean postoperative hospital stay of all the patients was  $15.4 \pm 37.8$  days in the FD group and  $37.3 \pm 86.2$  days in the FJ group ( $P < 0.001$ ). Operative and hospital mortality rates were not statistically significant between the two groups, respectively (Operative mortality: FD group; 0.9 %, FJ group; 0 %,  $P = 0.294$  and hospital mortality: FD group; 0.9 %, FJ group; 0.7 %,  $P = 0.880$ ).

## Discussion

Allowing postoperative patients to eat normal food at will early after major upper gastrointestinal surgery did not increase morbidity when compared with fasting and enteral feeding [9]. However, transthoracic esophagectomy comprised only 1.3 % of the patients who were entered onto this randomized trial. In stark contrast, most patients in the current study underwent resection of squamous cell carcinoma of the middle thoracic esophagus with lymphadenectomy of the upper mediastinum and suffer from varying degrees of transient recurrent nerve paresis resulting in dysphagia that could lead to aspiration, thus requiring more cautious approach in oral food intake [10].

The following are the objectives of administering catheter feeding jejunostomy : (1) to prevent villous atrophy and maintain gastrointestinal integrity by promoting peristalsis, blood flow and the secretion of digestive juices; (2) to maintain or enhance the immune function and reduce operative complications by the administration of immunonutrients; and (3) to avoid complications of parenteral nutrition such as catheter associated hematological infection and venous thrombosis, which are related to long-term indwelling central venous catheters. Furthermore, it has been reported that physical loss of the mucosal barrier due to long-term disuse of the gut as well as translocation of bacterial and/or inflammatory cytokines from the gut to the blood stream—so-called bacterial translocation—could be prevented with early postoperative enteral nutrition [11]. For these reasons, perioperative enteral feeding is recommended for patients undergoing highly invasive gastrointestinal surgery such as esophagectomy and to minimize postoperative complications [12–16]. However, disadvantages of jejunostomy include four major categories: (i) mechanical such as tube blockage or removal volvulus, internal hernia, and bowel obstruction; (ii) gastrointestinal such as diarrhea; (iii) infectious such as aspiration pneumonia, tube site infection; and (iv) metabolic such as re-feeding syndrome and hyperglycemia, [17–20]. Montejó et al. found that 24 % of patients experienced one or more gastrointestinal tract complications due to jejunal feeding in a multicenter observational study of 400 patients [21]. In the study of 111 patients with esophagectomy, Sadeesh et al. reported 5 % patients experienced complications attributable solely to the jejunostomy tube; 50 % of these patients with complications required surgery [22].

Mechanical obstruction after esophageal surgery is a critical problem because esophageal cancer patients are frequently malnourished and a fasting period could be life threatening and cause severe deterioration in the quality of life of these patients. Various methods to create enterostomy using different intestinal tract implantation sites, fixation positions, and fixation methods have been

proposed to prevent mechanical obstruction [23]. Despite due consideration given to proposals for jejunostomy in the literature, surgical complications were relatively frequent in the FJ group and even led to resection of a relatively large portion of the jejunum in one case. Complications following jejunostomy cannot be prevented unless we cease fixation of the jejunum to the abdominal wall. We eventually employed a new approach—creation of a duodenostomy. We actually came across a report written in Japanese that reported the possibility of an indwelling catheter in the gastric vestibule after retrosternal gastric tube reconstruction in esophageal cancer surgery, since the gastric tube had been elevated to just below the epigastric abdominal wall. However, infection is a concern in this method because the catheter passes through the gastric tube and aliment tends to stagnate. Additionally, insertion of a feeding tube via the gastric tube is not possible in patients who underwent posterior mediastinal gastric tube reconstruction. Even in retrosternal reconstruction, the linear route of catheterization via the gastric tube is not possible when the gastric tube is highly elevated and placed in the thoracic cavity. On the other hand, the duodenal bulb is always located directly beneath the epigastric abdominal wall regardless of the gastric tube reconstruction route. Thus, we eventually chose to place the feeding catheter linearly via the duodenal bulb, where aliment does not stagnate. In this new approach, abdominal abscess and fistula were concerns because of implantation of a foreign object into a site containing digestive fluid, although the fluid is not as active as that beyond the Vater's papilla. To prevent these complications, we covered the catheter completely with the adipose tissue around the round ligament of the liver so that the feeding tube is not exposed in the abdominal cavity. As a result, neither serious abscesses nor fistula formation was seen. The one incident of catheter site infection after this procedure resolved immediately after catheter removal. Another concern had been inflammation around the duodenal bulb or pylorus following leakage and/or catheter-related abscess, leading to gastric tube stasis due to edema of the duodenum and/or pylorus. Fortunately, this problem has not been observed to date. In addition, we believe that avoidance of fixation of the duodenum to the abdominal wall preserved duodenal peristalsis. Catheter implantation in the duodenum is not technically demanding; however, it is not easy to place the end of the tube into the jejunum because we cannot manipulate the catheter through the horizontal portion of the duodenum. In the actual procedure, the catheter is inserted while injecting approximately 50 ml of 0.9 % saline into the duodenum through the catheter. Using this approach, the tip passes through the ligament of Treitz and advances smoothly into the jejunum, although the feeding tube curls up while being pushed through the horizontal

part of the duodenum and needs to be straightened after reaching the jejunum. It is easier to shorten the indwelling catheter and place the end of the tube within the duodenum. However, this option is not recommended because the negative pressure in the thoracic cavity could result in reflux of the nutrients into the gastric tube.

The current study suffers from its retrospective nature. Patients in the two groups, the FD group and FJ group, underwent surgery at completely different periods and the outcome could have reflected several differences in perioperative managements and surgical techniques during the two periods that may not allow reliable head-to-head comparison on parameters such as the incidence of complications and the length of hospital stay. Another weakness is ambiguity in the accuracy of the true cause of mechanical bowel obstruction, which is actually crucial in the most important finding of study. We scrutinized surgical findings described in the medical records and attempted to identify the cause of mechanical bowel obstruction, to decide whether the adhesion around the site of tube insertion was indeed responsible. Despite the ambiguity, the dramatic decline in the incidence of mechanical obstruction in the FD group did implicate that the obstruction had some association with the method and cite of enteral tube insertion.

## Conclusions

To summarize, this is the first study evaluating a new procedure of feeding duodenostomy, implicating that the procedure is not technically demanding, and is associated with a lower incidence of surgical complications compared with feeding jejunostomy.

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**Conflict of interest** None.

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