Balloon dilatation of the pylorus for delayed gastric emptying after esophagectomy

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Objective: Delayed gastric emptying after esophagectomy occurs in up to 50% of patients. A good quality of life, in long-term survivors after esophagectomy, may depend on both dietary adaptation and the improvement of intrathoracic gastric motility itself. The objective of this study was to investigate the effect of pyloric balloon dilatation on the sustained delay of gastric emptying after esophagectomy.

Methods: Two hundred and fifty-seven patients underwent esophagectomy with a gastric conduit from January 2003 to December 2006. A gastric drainage procedure was routinely performed during the esophagectomy. The intrathoracic gastric emptying of solid food was evaluated by radioisotope imaging. A 50% gastric emptying time over 180 min was defined as delayed. We assessed the changes of the intrathoracic gastric emptying time, and the symptoms after balloon dilatation of the pylorus, associated with delayed gastric emptying.

Results: Balloon dilatation of the pylorus was performed in 21 patients (8%) who had sustained symptoms of delayed gastric emptying after esophagectomy despite the use of prokinetics. The symptoms associated with delayed gastric emptying were improved after balloon dilatation of the pylorus in all patients. Pyloric balloon dilatation was performed twice in two patients. In seven of 19 patients (37%), who had a follow-up gastric emptying study, the delayed gastric emptying rate for 180 min was improved from 30% to 88%. Six patients had slightly improved results, and six patients had no increase in the rate of gastric emptying compared with the previous gastric emptying study.

Conclusions: After balloon dilatation of the pylorus, two thirds of patients with delayed gastric emptying show increased rates of gastric emptying as measured by radioisotope imaging. Mechanical balloon dilatation of the pylorus is a useful method to treat sustained delay of intrathoracic gastric emptying after esophagectomy.

Keywords: Esophageal surgery; Esophageal cancer; Imaging

1. Introduction

Most surgeons use the stomach to restore gastrointestinal continuity after esophageal surgery for esophageal cancers. The quality of life, for long-term survivors, after esophagectomy, may depend on both dietary adaptation and the improvement of intrathoracic gastric motility itself. Delayed emptying of the gastric contents is a common problem after resection and reconstruction of the esophagus [1–4]. The various preparations of the stomach as an esophageal substitute and the pyloric drainage procedure to prevent gastric stasis secondary to incidental truncal vagotomy have serious effects on gastric emptying. Thoracic surgeons continue to debate the pros and cons of pyloric drainage following esophageal substitution with a gastric conduit after esophagectomy. Proponents consider a pyloric drainage as a method for prevention of aspiration pneumonia during the early postoperative period; but opponents argue that delayed gastric emptying after esophagectomy is actually rare, and in addition, pyloric drainage may induce dumping and bile reflux after esophagectomy [5,6]. Urschel et al. reported that pyloric drainage procedures reduce the occurrence of early postoperative gastric outlet obstruction after esophagectomy with gastric reconstruction, but that they have little effect on mortality, pulmonary morbidity and late postoperative foregut function [6]. Opponents argue further that when symptoms of delayed gastric emptying do occur, they often improve with time, and if not, they commonly respond to medical therapy [7–9] or endoscopic balloon dilatation [10].

We performed a pyloric drainage procedure following esophageal substitution with a gastric conduit after esophagectomy for esophageal cancer as a routine procedure. Nevertheless, some patients suffered from sustained symp-
toms with delayed gastric emptying despite the use of prokinetics. The aim of this study was to investigate the objective effects of pyloric balloon dilatation on the delayed gastric emptying after esophagectomy by measuring the gastric emptying time with radioisotope studies.

2. Materials and methods

Between January 2003 and December 2006, 257 patients underwent esophagectomy with gastric pull-up reconstruction at the National Cancer Center in Korea. The postoperative mortality rate was 1.2% (n = 3). A gastric emptying study with radioisotope imaging was routinely performed after the esophagectomy. We obtained informed consent from the patient or next of kin for measurement of gastric emptying time by radionuclide studies after the approval of the local institutional review board of our study protocol. Table 1 lists the patient characteristics.

2.1. Surgery

Most of patients with esophageal cancer underwent a transthoracic esophagectomy and systematic lymph node dissection with complete truncal vagotomy. The gastric conduit was pulled up with the whole stomach or after gastric tube formation. The gastric tube was constructed using linear stapling devices (TLC, Ethicon, Sweden) inserted into the lesser curvature 5 cm proximal to the pylorus. The patients had either manually sutured anastomoses in the neck or circularly stapled anastomoses at the apex of the right chest or at the neck. The esophageal hiatus provided sufficient space for three or four fingers to be inserted. Gastric drainage was routinely performed with finger disruption of the pylorus. This procedure is to pinch or crush the pylorus to break the pyloric ring. After surgery, the patients were extubated in the operating room and transferred to the intensive care unit. All patients were managed in the ICU for one night. Postoperative pain control was mainly achieved using epidural analgesia.

2.2. Dietary modification

Esophagography was performed on postoperative day 7. Sips of water were allowed after confirming the absence of anastomosis leakage, and a full liquid diet was implemented on the following day. If the patient tolerated the liquid diet, the diet was advanced to a soft-food diet. All diets were divided into at least six portions per day. We recommended that walking exercise be performed soon after the food was consumed. This dietary modification was maintained for 30 days or as needed. Diet advancement to a regular diet was considered during the follow-up period according to the patient’s condition. If a patient had delayed gastric emptying symptoms, prokinetic medications such as erythromycin or itopride were recommended for treatment.

2.3. Radionuclide investigation of intrathoracic gastric emptying

Scintigraphy was performed in patients who fasted for at least 8 h, and were positioned standing in front of a gamma camera (ARGUS, ADAC, Milpitas, CA, USA) connected to a microcomputer. The field of view included the throat and the upper abdomen. The investigation of gastric emptying began with the consumption of solid food labeled with 2 mCi of technetium (99 m-DPTA). The 300 g meal consisted of scrambled eggs mixed with 2 mCi technetium (99 m-DPTA, 50 g), 200 g of rice rolled with seaweed (a kind of sushi) and 50 g of yogurt. Anterior images were taken within 1 min of the completion of the meal (defined as time 0) and then at 20 min intervals for the following 180 min. Between imaging periods, the subjects were allowed to sit or walk in an adjacent waiting area. Power exponential fitting was used to analyze the time—activity curve over the stomach and to calculate the 50% gastric emptying time. The time—activity curves were analyzed for residual activity. For evaluation of the gastric conduit, the interval from the onset of deglutition to the point when the conduit activity fell to 50% of the peak activity was measured. This was defined as the 50% gastric emptying time (T_{50}). The T_{50} was divided into three ranges:

![Fig. 1. Radionuclide imaging of the intrathoracic gastric emptying at 120 min. (A) Intermediate gastric emptying was defined as 50% of the gastric emptying within 180 min. (B) Delayed gastric emptying was defined as 50% of the gastric emptying that took more than 180 min. (C) Rapid gastric emptying was defined when the radioisotope was dumped into the small intestine immediately after swallowing a radiolabeled meal.](image-url)
over 180 min was defined as delayed, within 180 min as intermediate and when all the radioisotopes were dumped into the jejunum as soon as swallowed, as rapid (Fig. 1). The gastric emptying study with isotope imaging has been available since February 2003.

2.4. Balloon dilatation of pylorus

A guide-wire was first placed to transverse the stenosis. Catheterization was easily achieved with a 6.5 F polyethylene catheter and a 0.038 in. stiff hydrophilic guide-wire was introduced orally under fluoroscopic guidance. The median balloon size was 20 mm (18—25 mm), and each balloon was inflated for waist obliteration during 15—20 min using 2—3 atm of pressure (Fig. 2). A dilute solution of water-soluble contrast (e.g. gastrograffin) was used to improve visualization. The procedure was painless and did not require analgesia. Post-dilatation evaluation with contrast material showed the pyloric canal widely open. Feeding with clear liquids was started 8 h later.

2.5. Statistics

Data was analyzed using SPSS for Windows, version 12.0 (SPSS, Inc., Chicago, IL, USA). The values are expressed as mean ± standard deviation. The Wilcoxon signed-ranks test as a non-parametric analysis was used to compare the gastric emptying data before and after balloon dilatation. An overall probability value $p < 0.05$ was considered statistically significant. Estimates of survival were obtained using the Kaplan—Meier method.

3. Results

A fluoroscopy-guided balloon dilatation was performed in 21 patients with sustained symptoms of delayed gastric emptying after esophagectomy for esophageal cancer. We chose the fluoroscopy-guided procedure rather than an endoscopic balloon dilatation because the former can be performed easily with patient comfort and without the need for sedation. In addition, we could visualize the passage of gastric contents immediately after the procedure with dye injection.

The overall incidence of gastric outlet obstruction requiring mechanical dilatation was 8% (21/257). A balloon dilatation for an anastomosis stricture was performed in 53 patients (21%). Nine patients underwent balloon dilatation at both the pylorus and the anastomosis site. All patients were males with an average age of 66.4 ± 7.94 years. The majority complained of delayed gastric emptying symptoms such as dysphagia, vomiting and early satiety after the esophagectomy at the first follow-up visit after discharge. The median interval between surgery and the balloon dilatation was 2 months (range: 1—19 months). In 19 patients (91%), a balloon dilatation of the pylorus was performed within 6 months. Among 257 patients, the whole stomach was used in 205 patients (80%) and a gastric tube was applied in 52 (20%). Among 205 patients with the whole stomach, 15 patients (7%) required pylorus balloon dilatation. Among 52 patients with a gastric tube, six patients (12%) required pylorus balloon dilatation. The median follow-up interval was 26 months. The overall 4-year survival was 72.1% and the disease free survival was 55.1%.

The clinical symptoms associated with delayed gastric emptying improved immediately after the balloon dilatation of the pylorus in all patients. However, balloon dilatation of the pylorus was repeated in two patients 3 and 4 months later, due to the recurrence of symptoms. No complication related to the balloon dilatation of the pylorus was noted. At the initial diagnosis, the mean gastric emptying ratio for

Fig. 2. Fluoroscopy-guided balloon dilatation of the pylorus. (A) Fluoroscopy showed poor passage of the gastrograffin at the level of the pylorus. (B) Balloon dilatation was performed at the level of the pylorus.
180 min was 35 ± 17% and the $T_{50}$ was 401.2 ± 329.7 min (Table 2).

The follow-up of the gastric emptying was investigated in 19 of these patients: gastric emptying was much improved in seven and slightly improved in six. However, the other six patients showed no change in gastric emptying time before and after comparisons of the balloon dilatation of the pylorus. The beneficial effects of balloon dilatation of the pylorus on gastric emptying were observed in 68% (13/19) of the patients. In seven cases with dramatically improved gastric emptying, the gastric emptying rate for 180 min was changed from 30 ± 14% to 88 ± 9% along with the resolution of symptoms (Fig. 3).

4. Discussion

With the advancement of surgical techniques, postoperative morbidity and mortality rates have remarkably improved. In-hospital mortality rates after esophagectomy before the 1990s were over 10% and they fell to around 5% in the 2000s when performed in large centers [11—14]. Improvement of postoperative results as well as the survival after esophagectomy for esophageal cancer led to the interest of the quality of life in survivors after esophagectomy. Patients who have undergone an esophagectomy frequently suffer from early satiety, reflux, some degree of dumping, and swallowing difficulty. Most patients can consume a near-normal diet 1 year after surgery. However, a long-term follow-up showed a 62% incidence of postoperative symptoms, although 84% of patients were able to maintain a normal diet and 87% returned to work [15]. Only a minority was completely symptom free 5 or more years after esophageal resection [16]. Delayed gastric emptying after gastric and esophageal operations occurs in up to 50% of patients [17—19].

Proponents of routine pyloric drainage during gastric reconstruction of the esophagus strive to avoid postoperative gastric outlet obstruction related to denervation of the stomach [5,20—22]. They argue that a subset of patients will experience poor gastric emptying after esophagectomy, and that gastric outlet obstruction causes early and late adverse outcomes. During the first weeks after surgery, gastric outlet obstruction may lead to pulmonary aspiration (occasionally
lethal) or recurrent pneumonia secondary to unconscious pulmonary aspiration. In addition, gastric outlet obstruction negates the palliative benefit of esophagectomy; the patients can swallow, but they cannot eat. Finally, proponents of routine pyloric drainage believe that gastric stasis is more detrimental to long-term nutritional status and quality of life than occasional episodes of bile reflux.

Surgeons opposed to routine pyloric drainage point out that only a minority of patients develop gastric emptying problems after esophagectomy and that this complication can be successfully managed with prokinetic medications or endoscopic balloon dilatation of the pylorus. They also contend that the postesophagectomy foregut function improves with time, with or without a pyloric drainage procedure [9,10]. Finally, they emphasize the role of pyloric drainage in the genesis of bile reflux and dumping.

A meta-analysis performed by Urschel et al. showed that a pyloric drainage procedure, performed at the time of gastric reconstruction and esophagectomy, reduces the occurrence of early postoperative gastric outlet obstruction [6]. However, the impact of pyloric drainage on overall complications, respiratory complications, and late postoperative foregut function is far from certain. The meta-analysis shows that the presence or absence of a pyloric drainage procedure has little impact on most relevant patient outcomes. Recently, Lanuti et al. reported that pulmonary morbidity, mortality and the incidence of early and/or late gastric outlet obstruction was not influenced by pyloromyotomy after esophagectomy with gastric conduit, and gastric outlet obstruction could be successfully managed postoperatively with endoscopic balloon dilatation in most situations. Ninety-seven percent of patients who developed early or late gastric outlet obstruction could be managed with pyloric dilatation with endoscopic means despite an intact pylorus or previous pyloromyotomy [23]. Collard et al. showed that a sensation of early fullness and dysphagia in the major long-term complaints after esophagectomy occurs in up to 50% of patients [18]. In addition, we previously reported that the gastric emptying of solid foods, immediately after esophagectomy, was markedly delayed in about 50% of patients in spite of the disruption of pylorus during esophageal reconstruction with stomach, but this improved over time [19]. Gastric outlet obstruction after pyloric drainage procedure, within 6 months after surgery, may be

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**Fig. 4.** Flow management of delayed gastric emptying after esophagectomy with gastric reconstruction.
associated with incomplete disruption of pylorus ring or postoperative edema or inflammatory changes at the pyloroplasty site. However, in this study, only 8% of patients needed mechanical balloon dilatation and about 70% had its objective benefit for delayed gastric emptying. This implies that the symptoms of delayed gastric emptying do not always correlate with the measured gastric emptying times. More delayed emptying did not correlate with more symptoms. When the patients, after esophagectomy, have symptoms of gastric outlet obstructive symptoms, we treat them with prokinetics such as erythromycin without confirmation of the delayed gastric emptying by objective testing. Although about 30% of patients did not respond to the balloon dilatation in this study, they felt better immediately after the procedure. Even if they had recurrent symptoms, the prokinetics and dietary modification led to improvements over time. Therefore, an algorithm, such as the one shown in Fig. 4, is necessary to manage delayed gastric emptying after esophagogastrectomy with gastric reconstruction.

In conclusion, the clinical symptoms associated with delayed gastric emptying improved immediately after balloon dilatation of the pylorus. The results of this study showed the objective effects of balloon dilatation of the pylorus on the delayed gastric emptying by measuring the gastric emptying time with radioisotope imaging. The pylorus plays an important role in the control of gastric emptying after an esophagectomy. Delayed gastric emptying can be resolved by balloon dilatation of the pylorus with satisfactory results, whether a gastric drainage procedure is used or not.

References


Appendix A. Conference discussion

Dr A. Lerut (Leuven, Belgium): Over the last decade the overall results of esophagectomy for cancer have continuously improved, with now, approximately 40% of the patients surviving for more than 5 years. As a result, the number of long-term survivors is increasing and consequently, more attention is paid to the quality of life. As you explained, gastric emptying, gastric outlet obstruction, is a relevant topic indeed. But as you indicated, the debate is still on as to whether to add or not to add a pyloric drainage. Generally speaking, it seems when using the whole stomach, that the need for a pyloric drain is greater, however with an increased risk for dumping duodenal reflux and, more importantly, with an increasing number of reports now on the development of intestinal metaplasia, Barrett’s metaplasia, in the remnant of the cervical esophagus.

When using a small gastric tube, however, the need for pyloric drainage seems to be less important because the tendency of delayed gastric emptying is less according to the law of LaPlace.

I have a few questions, in fact five.

In how many of your patients induction chemo and/or radiotherapy had been used? And if so, did it influence gastric emptying as it is my impression that it does affect gastric emptying. Did you also perform preoperative emptying studies so that you have a reference value on the gastric emptying before surgery? And in this respect, how do you explain that, in fact, 36% of the patients had delayed gastric emptying, but only one-fourth was symptomatic. How do you explain that patients still stay asymptomatic despite the fact that for solid meals there is indeed delayed gastric emptying time?

As to the symptomatic group: the gastric emptying after balloon dilatation did not improve the measured values in two-thirds of those patients. What is the reason for not seeing an improvement of these values? Is that because of insufficient pyloric drainage, that is to say a failure of the procedure of pyloric drainage, or is it more a generalized problem of motility disorders of the whole stomach or gastric tube perhaps related, for instance, to induction therapy? The fourth question, is pyloric drainage indeed really necessary, and how many of your patients developed dumping duodenogastric reflux or eventually developed Barrett’s metaplasia in the remaining esophagus?

And finally, as to the prokinetic drugs, what is the optimal dose and for how long should it be given?
Dr Lee: Regarding prokinetics, initially, immediately after operation we used prokinetics such as metoclopramide or itopride. When delayed gastric emptying was sustained, erythromycin was added. During hospitalization we used the erythromycin IV, intravenously, about 200 mg. In outpatient department, we used the erythromycin 500 mg until the subsidence of the symptoms.

And regarding neoadjuvant therapy, only 11 patients underwent neoadjuvant chemo or concurrent chemoradiotherapy. We are ongoing the multi-center prospective controlled study for the comparison between surgery and surgery plus adjuvant chemotherapy for esophageal cancer in our country. So we prefer surgery first. I cannot exactly talk about the effect of neoadjuvant therapy on the gastric emptying.

And regarding the reason for delayed gastric emptying in spite of gastric drainage procedure, the delayed gastric emptying may be associated with incomplete disruption of pylorus or postoperative edema or inflammatory change at the site of pyloroplasty site. In the past, we thought that they were main reasons, but after this gastric emptying study we found another important factor. I will show the gastric emptying imaging. I found the two narrowing points. Here is pylorus. Here is another narrowing point. Hiatus.

Previously we made hiatus width with just 3 fingers. After this study, we widened the hiatus with 4 fingers. In the hiatus with 3 fingers, the proportion of delayed gastric emptying was about 50%. Since we have changed our policy, in 4-finger hiatus width, the proportion of delayed gastric emptying decreases to about 30%.

And this is the preliminary analysis over 200 patients. The hiatus width was very important. This was statistically significant by multivariater analysis. The gastric emptying images within 20 min showed the slope was very acute in 4 fingers group. The other was very similar.

And some people are wondering whether 3 or 4 fingers are objective measurement. Many surgeons have different fingers in size. However, just 1 finger led a big difference. This is my hand, this is my colleague’s hand. My glove size is 7, and his glove size 8. The lengths of hands are quite different. But the finger widths are in 3 fingers just 6 cm, and 4 fingers just 8 cm. If it is hypothesized that the hiatus has elliptical shape, the area of hiatus is \( \pi \times ab \). The area for 3 fingers is 300\( \text{mm}^2 \) and that for the 4 fingers is 600\( \text{mm}^2 \). The power of one finger can lead two times bigger in hiatus area.

Dr A. Jilaihawi (Glasgow, United Kingdom): I think you answered some of my questions about the width of the hiatus which is important. I’ve noticed that you had more with Ivor-Lewis, is that right, you have more problems, delayed emptying, with Ivor-Lewis?

Dr Lee: No. In our institute even if low esophageal cancer, we made the anastomosis at the level of the thoracic inlet or above the thoracic inlet.

Dr L. Zhang (Guangzhou, China): The first question is, how do you think about the relationship between anastomosis stenosis and gastric emptying delay? If yes, how many cases of the anastomosis stenosis occurred in your group? If not, why still some patients in your group received balloon dilation in anastomosis site?

Dr Lee: The first one is the relationship of anastomosis stricture and gastric emptying rate?

Dr Zhang: Yes.

Dr Lee: Why do you think about the relation between anastomosis and gastric emptying?

Dr Zhang: I don’t think gastric emptying delay is caused by anastomosis stenosis. But in your presentation, you gave some patients dilation in anastomosis site. So I want to know, how many cases of anastomosis structure in your group? Do you think anastomosis site dilation can solve the problem?

Dr Lee: During the follow-up in outpatient department, some patients complain the dysphagia, specifically at the neck area. And some patients during swallowing, immediately after swallowing they vomit. This situation makes me suspect the anastomosis stricture. I perform the pyloric dilatation at the stricture for the relief of the symptoms. I don’t know the exact relationship between anastomosis stricture and gastric emptying rate.

Dr H. Chen (Shanghai, China): I have two questions. One is concerning the emptying test. You decide 300-g meal for every patient for the emptying test, but you know the patients are different. Maybe patients eat more or eat less, they are different. Do you think this influences the result?

The second question is your finger damage pylorus, how do you control the quality of damage of the pylorus?

Dr Lee: Regarding the finger disruption of pylorus, the finger disruption means just pinching or crushing the pylorus at the site between the anterior portion and posterior portion. After this procedure, I can feel the break of the pylorus.

Regarding your first question, 300-g meal is applied in all patients. And I think the 300-g meal is used as a regular amount. The radioisotope activity in this study was calculated with the ratio of the radioisotope activity. So the amount of meal is not important.

Dr L. Zhang: Regarding your first question, 300-g meal is applied in all patients. And I think the 300-g meal is used as a regular amount. The radioisotope activity in this study was calculated with the ratio of the radioisotope activity. So the amount of meal is not important.