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ABOUT COVER

Editorial board member of *World Journal of Gastrointestinal Surgery*, Dr. Ying Fan is a Professor at China Medical University. Dr. Fan was promoted to Associate Professor & Deputy Chief Surgeon without exception in 2011. He has published more than 40 articles in Chinese and 20 SCI-indexed articles as first author or corresponding author. Currently, he is Deputy Director of the Second Department of General Surgery, Shengjing Hospital of China Medical University, member of the Expert Committee of Biliary Calculi Surgery of the Chinese Branch of the International Hepatobiliary and Pancreatic Association, member of the International College of Surgeons (ICS) for Biliary Surgery and Minimally Invasive Surgery, and review expert for the National Natural Science Foundation of China. (L-Editor: Filipodia)

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Distal gastric tube resection with vascular preservation for gastric tube cancer: A case report and review of literature

Masahiro Yura, Kazuo Koyanagi, Kiyohiko Adachi, Asuka Hara, Keita Hayashi, Yuki Tajima, Yasushi Kaneko, Hiroto Fujisaki, Akira Hirata, Kiminori Takano, Kumiko Hongo, Kikuo Yo, Kimiyasu Yoneyama, Reiko Dehari, Motohito Nakagawa

ORCID number: Masahiro Yura 0000-0003-4150-2085; Kazuo Koyanagi 0000-0002-8010-8630; Kiyohiko Adachi 0000-0002-7952-6616; Asuka Hara 0000-0002-3295-9094; Keita Hayashi 0000-0002-4022-7627; Yuki Tajima 0000-0002-9121-0227; Yasushi Kaneko 0000-0003-4854-7673; Hiroto Fujisaki 0000-0002-3719-4924; Akira Hirata 0000-0001-6836-1177; Kiminori Takano 0000-0003-0366-8367; Kumiko Hongo 0000-0001-5150-7838; Kikuo Yo 0000-0002-1971-0390; Kimiyasu Yoneyama 0000-0001-5715-7365; Reiko Dehari 0000-0003-0812-9549; Motohito Nakagawa 0000-0003-0507-444X.

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Masahiro Yura, Kiyohiko Adachi, Asuka Hara, Keita Hayashi, Yuki Tajima, Yasushi Kaneko, Hiroto Fujisaki, Akira Hirata, Kiminori Takano, Kumiko Hongo, Kikuo Yo, Kimiyasu Yoneyama, Motohito Nakagawa, Department of Surgery, Hiratsuka City Hospital, Kanagawa 2540065, Japan

Kazuo Koyanagi, Department of Gastroenterological Surgery, Tokai University School of Medicine, Isehara 2591193, Japan

Reiko Dehari, Department of Surgical Pathology, Hiratsuka City Hospital, Kanagawa 2540065, Japan

Corresponding author: Masahiro Yura, MD, Doctor, Surgeon, Department of Surgery, Hiratsuka City Hospital, 1-19-1, Minamihara, Hiratsuka-shi, Kanagawa 2540065, Japan. myura@ncc.go.jp

Abstract

BACKGROUND

Survival rates in patients with esophageal cancer undergoing esophagectomy have improved, but the prevalence of gastric tube cancer (GTC) has also increased. Total resection of the gastric tube with lymph node dissection is considered a radical treatment, but GTC surgery is more invasive and involves a higher risk of severe complications or death, particularly in elderly patients.

CASE SUMMARY

We report an elderly patient with early GTC that had invaded the duodenum who was successfully treated with resection of the distal gastric tube and Roux-en-Y (R-Y) reconstruction. The tumor was a type 0-IIc lesion with ulcer scars surrounding the pyloric ring. Endoscopic submucosal resection was not indicated because the primary lesion was submucosally invasive, was undifferentiated type, surrounded the pyloric ring, and had invaded the duodenum. Resection of distal gastric tube with R-Y reconstruction was safely performed, with preservation of the right gastroepiploic artery (RGEA) and right gastric artery (RGA).

CONCLUSION

Distal resection of the gastric tube with preservation of the RGEA and RGA is a good treatment option for elderly patients with cT1bN0 GTC in the lower part of the gastric tube.

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Core Tip: Surgical removal of the reconstructed gastric tube is invasive and carries a relatively high risk of postoperative morbidity and mortality, especially for elderly patients. We present the case of an 82-year-old man who underwent successful resection of distal gastric tube for early gastric tube cancer with duodenal invasion. The interesting features of this case include the advanced age of the patient, distal resection of a gastric tube reconstructed *via* the posterior mediastinal route, and preservation of the right gastroepiploic artery and right gastric artery. None of these features have been described in previous reports.

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INTRODUCTION

Gastric and head and neck cancers are the most frequent malignancies co-occurring with esophageal cancer^[1]. Recent advances in the diagnosis and treatment of esophageal cancer have improved prognosis after esophagectomy but have also led to an increasing occurrence of gastric tube cancer (GTC). While the use of endoscopic resection for early GTC without lymph node (LN) metastasis has increased^[2-4], total resection of the gastric tube with LN dissection is considered the standard radical treatment for GTC when endoscopic submucosal dissection (ESD) is not indicated. Surgical removal of a reconstructed gastric tube is an invasive procedure that involves a higher risk of postoperative morbidity and mortality^[5]. In particular, the possibility of LN metastasis and operative mortality must be carefully considered in choosing the surgery. Less invasive surgery should be considered for elderly and other high-risk patients even if there is a risk of LN metastasis. Distal resection is one of the less invasive procedures for patients with early GTC located on the distal side of the gastric tube. Moreover, preservation of the main trunk of the right gastroepiploic artery (RGEA) and the right gastric artery (RGA) would retain the main blood supply to the reconstructed gastric tube, given that the other gastric vessels were divided during the previous surgery. Several reports have described successful partial resection for early GTC^[6,7]. Here, we present a successful case of surgical treatment for GTC and provide details of the surgical procedure. The noteworthy features of this case include the advanced age of the patient (82 years; older than in any previous surgical reports), GTC invading the duodenum, previous reconstruction *via* the posterior mediastinum, and resection of the distal gastric tube while preserving the RGEA and RGA.

CASE PRESENTATION

Chief complaints

An 82-year-old man presented to the Department of Surgery of the Hiratsuka City Hospital (Japan). He had no complaints and had continued to visit the hospital for routine postoperative follow-up examinations after esophagectomy for esophageal cancer.

History of present illness

The patient had undergone subtotal esophagectomy with gastric tube reconstruction *via* the posterior mediastinal route for esophageal cancer 13 years earlier. No recurrence was detected, but gastric tube cancer was found during a routine follow-up 13 years after the original subtotal esophagectomy.

History of past illness

The patient had hypertension, chronic renal disease, and a history of subtotal esophagectomy with posterior mediastinal reconstruction for esophageal cancer 13 years earlier. Pathological examination of the resected esophageal cancer revealed a basaloid carcinoma with invasion of the submucosa, diagnosed as pT1bN0M0, p-stage I according to the Union for International Cancer Control Tumor Node Metastasis Classification of Malignant Tumors, 8th edition^[8].

Physical examination

No noticeable physical findings other than the previous surgical incision were observed.

Laboratory examinations

A blood analysis revealed mild anemia (hemoglobin; 12.3 g/dL) with normal white blood cell and platelet counts. Prothrombin and partial thromboplastin times were normal. Blood biochemistry revealed chronic renal disease (creatinine, 1.09 mg/dL; Creatinine clearance, 46.7 mL/min) and increased brain natriuretic peptide 128.5 pg/mL (normal range: < 18.0 pg/mL).

An electrocardiogram showed ST-T abnormalities on leads II, III, aVf, and V4-6. Echocardiography revealed almost normal cardiac function with mild aortic stenosis. A pulmonary function examination revealed the following: Vital capacity, 72.6% of predicted; and forced expiratory volume in 1 s, 67.7% of predicted (1.57 L). A chest X-ray showed the reconstructed gastric tube in the mediastinum.

Imaging examinations

Endoscopic examination revealed a type 0-IIc tumor with an ulcer scar surrounding the pyloric ring and invading the duodenum. The lesion was not stained by indigo carmine (Figure 1A and B). Computed tomography was unable to detect the primary tumor, and no obvious nodal metastasis was observed (Figure 2A-D).

FINAL DIAGNOSIS

Pathological examination of the resected specimen revealed a moderately to poorly differentiated adenocarcinoma with submucosal invasion and ulcerative scars (UL-IIs-IIIs) without lymphovascular invasion (Figure 3A and B). The cancer had invaded the duodenum. The horizontal and vertical surgical margins were negative, and the #6LN was negative for metastasis. The pathological diagnosis was pT1bN0M0 pStage IA.

TREATMENT

Biopsies were taken, and the histological examination led to a diagnosis of a moderately to poorly differentiated adenocarcinoma. The preoperative GTC stage was LD circ cT1bN0M0 cStage I according to the Japanese Classification of Gastric Carcinoma, 15th edition^[9].

ESD was not indicated for the GTC based on guidelines for treating gastric cancer^[10] because the lesion was diagnosed as an undifferentiated type with submucosal invasion. Additionally, the lesion surrounded the pyloric ring and had invaded the duodenum, so ESD would have been technically difficult. Surgical risk factors for this patient included his advanced age (82 years), poor pulmonary function, chronic renal disorder, hypertension, and history of subtotal esophagectomy with posterior mediastinal reconstruction and mild aortic stenosis. The therapeutic strategy was explained to the patient, who opted to undergo surgery.

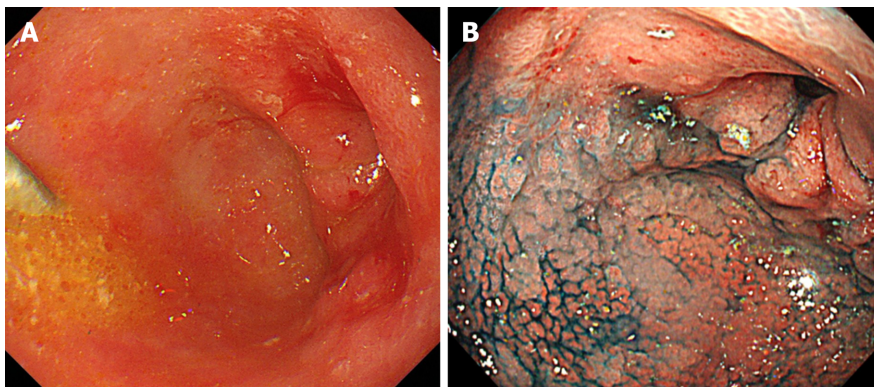


Figure 1 Endoscopic findings. A: Esophagogastroduodenoscopy revealed a 0-IIc primary tumor with ulcerations surrounding the pyloric ring; B: The lesion was unstained by indigo carmine.

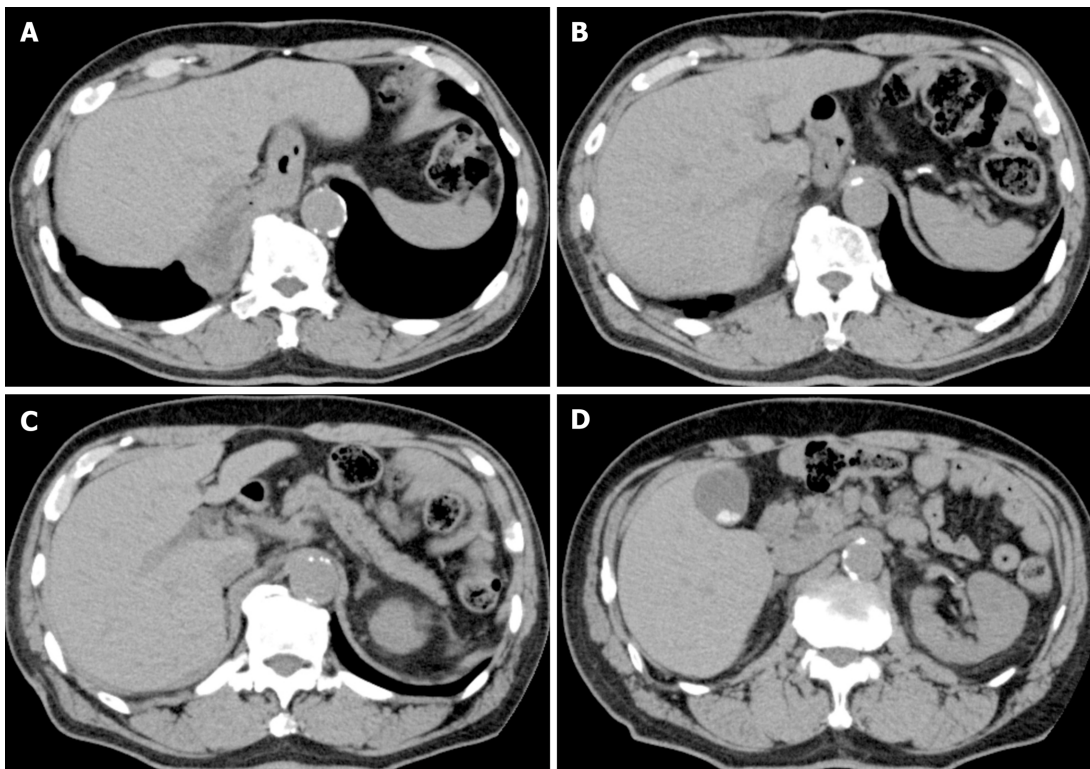


Figure 2 Computed tomography findings. A-D: Computed tomography was unable to detect the primary tumor, and no obvious nodal metastasis was observed.

Resection of the distal gastric tube and Roux-en-Y reconstruction preserving the main trunk of the RGEA and RGA

Delamination was performed between the omentum and abdominal wall along the previous surgical wound. The gastric tube was then mobilized by separating the anterior and posterior lobes of the mesocolon up to the vicinity of the root of the right gastroepiploic vein. After a Kocher mobilization, the RGA, RGEA, and infrapyloric artery supplying blood to the gastric tube were identified. To preserve the main trunks of the arteries, peripheral branches to the stomach wall were cut according to the area to be resected (Figure 4A and B). We also performed #6LN sampling because of swelling, but the sample was not submitted for an intraoperative pathological examination. The duodenum was cut as distally as possible to maintain an adequate surgical margin, using a 60-mm Endo GIA Reinforced Reload with Tri-Staple stapler (Covidien, Mansfield, MA, United States). Esophagogastroduodenoscopy was performed during surgery to determine the proximal cutting location line. The gastric tube was cut in the abdominal cavity using a 60-mm stapler. Gastrojejunostomy (GJ) was performed with the stapler, and the antecolic R-Y reconstruction was completed.

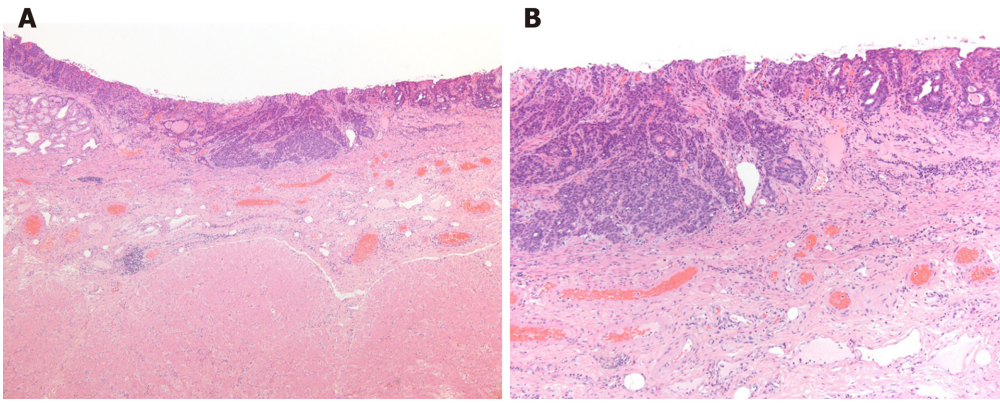


Figure 3 Pathological findings. Pathological examination of the resected material revealed a moderately to poorly differentiated adenocarcinoma with submucosal invasion and ulcerative scars, but without lymphovascular invasion. A: Hematoxylin and eosin staining results, $\times 4$; B: Hematoxylin and eosin staining results, $\times 10$.

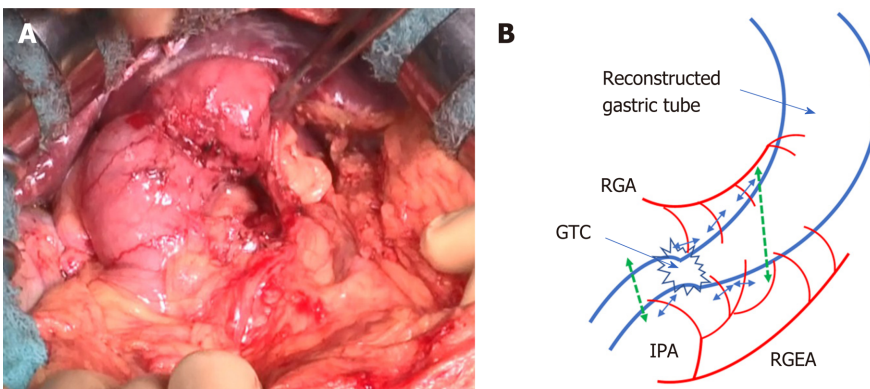


Figure 4 Tumor location. The peripheral branches to the stomach wall were cut according to the area to be resected, to preserve the main trunks of the right gastric artery and right gastroepiploic artery. Photograph taken during surgery showing the resected branches of the infrapyloric artery. Schematic of the dissection line. GTC: Gastric tube cancer; IPA: Infrapyloric artery; RGA: Right gastric artery; RGEA: Right gastroepiploic artery.

GJ was performed on the anterior wall of the greater curvature to avoid vessel injury (Figure 5A and B). Resection of the distal gastric tube was successful, and the proximal side was preserved without the need for thoracotomy. Sufficient surgical margins were confirmed in the resected material. The total operation time was 4 h 48 min, and total blood loss was < 10 mL.

OUTCOME AND FOLLOW-UP

Postoperative course

The patient was able to drink water on postoperative day 1, resumed eating on postoperative day 2, and was discharged on postoperative day 12 without any surgical complications (Clavien-Dindo grade > 3)^[11]. The patient's diet and activities of daily living were the same as before surgery.

DISCUSSION

We present the case of an 82-year-old man who underwent successful resection of distal gastric tube for early GTC with duodenal invasion. The interesting features of this case include the advanced age of the patient, distal resection of a gastric tube reconstructed *via* the posterior mediastinal route, and preservation of the RGEA and RGA. None of these features have been described in previous reports. In general, total resection of the gastric tube with LN dissection is considered the standard radical treatment for GTC for which ESD is not indicated. However, surgical removal of the

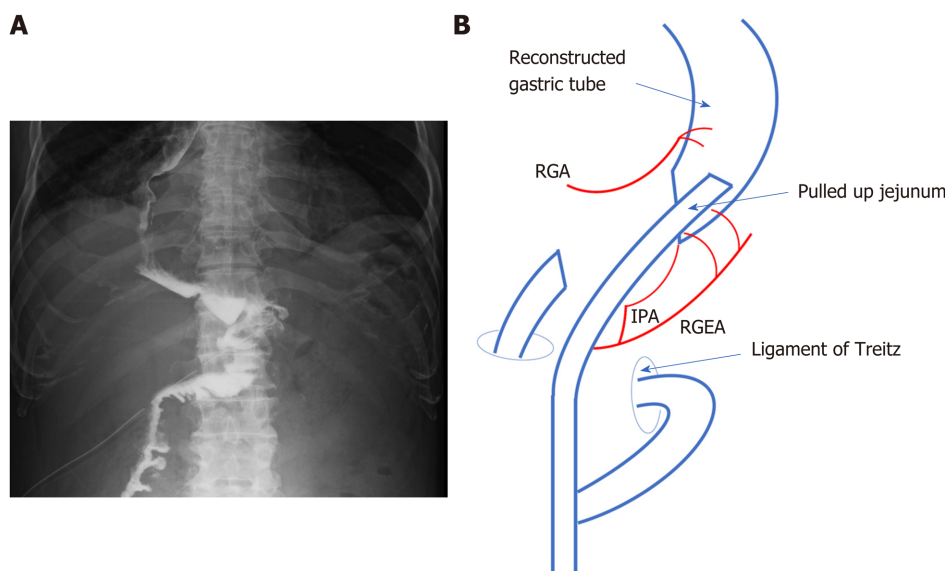


Figure 5 Roux-en-Y reconstruction. Barium swallow test with antecolic Roux-en-Y reconstruction. Schematic of gastrojejunostomy with antecolic Roux-en-Y reconstruction. IPA: Intrapyloric artery; RGA: Right gastric artery; RGEA: Right gastroepiploic artery.

reconstructed gastric tube is invasive and carries a relatively high risk of postoperative morbidity and mortality^[5]. Furthermore, this procedure is complicated when the reconstruction route selected at the original esophagectomy was *via* the posterior mediastinum, because the gastric tube is surrounded by vital organs, including the heart, lungs, and aorta. We previously reported that the level of difficulty of the surgical procedure differs according to the route of reconstruction, and accounts for differences in the resection rate (50%, 77%, and 93% for the posterior mediastinal, retrosternal, and ante-thoracic routes, respectively)^[12]. Because a gastric tube pulled up *via* the posterior mediastinal route exists in the deepest part of the abdomen, even partial resection will be difficult unless the lesion is located near the pyloric ring, as in the present case. However, in elderly and high-risk patients with early GTC without LN metastasis, distal resection of the gastric tube is considered to be a safer surgical technique than complete resection of the gastric tube.

Due to recent advances in the diagnosis and treatment of esophageal cancer, surgical outcomes have improved and the prevalence of GTC after esophagectomy has increased to 2.1%-3.5%^[2,13]. The characteristics and treatments of 224 GTC patients reported in 29 studies (12 retrospective studies and 17 case reports) between 1998 and 2020 (Table 1)^[3-6,12,14-37] showed that the mean age of patients at the time of GTC treatment was 67.2 years (range: 43-85 years), and 202 patients (90.2%) were male. According to the available data of these studies, the majority of GTCs were the differentiated type (77.3%; $n = 160$), followed by the undifferentiated type (19.8%; $n = 41$), and others (mixed type, neuroendocrine carcinoma, squamous cell carcinoma; $n = 7$). The majority of the lesions were located in the lower part of the gastric tube (59.4%; $n = 107$), while the middle third was the second most common location (32.2%; $n = 58$). Endoscopic mucosal resection and ESD were the most frequently used treatments ($n = 138$), followed by total or subtotal resection ($n = 44$), partial resection ($n = 31$), chemotherapy/chemoradiotherapy/palliative treatment ($n = 19$), and distal resection or antrectomy of the gastric tube ($n = 5$). The mean time from the original esophageal cancer to GTC was 60.9 mo (range: 4-236 mo).

In our patient, GTC was detected 13 years after esophagectomy. Thus, long-term follow-up (> 5 years) is necessary to detect GTC in the early stage after esophagectomy. Early detection allows less invasive and curative treatment *via* ESD, partial resection, or resection of the gastric tube, without the need for total gastric tube resection. The efficacy and safety of endoscopic resection for GTC have been demonstrated in several studies^[2,4,33]. Hirayama *et al*^[4] reported an 85% (28/33) curative resection rate using ESD for early GTC, and the 2- and 5-year overall survival rates were 73.3% and 64.1%, respectively. Nonaka *et al*^[2] reported that the disease-specific 5-year survival rate in non-curative patients after ESD was 72.7%. Additional surgery was not performed in 15 of 16 (94%) non-curative resection patients at risk of LN metastasis. These survival rates were considered acceptable in the present case, because the 5-year survival rate of a general 82-year-old male cohort in Japan is

Table 1 Studies included in the review

Ref.	Publication year	Journal	Study type	Number of patients
Horie <i>et al</i> ^[36]	2020	<i>Asian J Endosc Surg</i>	Case report	1
Yamana <i>et al</i> ^[35]	2020	<i>Int J Surg Case Rep</i>	Case report	1
Hara <i>et al</i> ^[34]	2020	<i>Surg Case Rep</i>	Case report	1
Hirayama <i>et al</i> ^[4]	2019	<i>Esophagus</i>	Retrospective study	29
Shirakawa <i>et al</i> ^[6]	2018	<i>Esophagus</i>	Retrospective study	30
Mukasa <i>et al</i> ^[33]	2015	<i>World J Gastroenterol</i>	Retrospective study	11
Lee <i>et al</i> ^[32]	2014	<i>Eur J Cardiothorac Surg</i>	Retrospective study	18
Tawaraya <i>et al</i> ^[3]	2014	<i>Gastrointest Endosc</i>	Retrospective study	15
Ho <i>et al</i> ^[31]	2014	<i>Dis Esophagus</i>	Case report	4
Kim <i>et al</i> ^[30]	2012	<i>Korean J Thorac Cardiovasc Surg</i>	Case report	1
Saito <i>et al</i> ^[29]	2012	<i>J Surg Oncol</i>	Case report	2
Jabłoński <i>et al</i> ^[28]	2012	<i>World J Surg Oncol</i>	Case report	1
Shiozaki <i>et al</i> ^[27]	2012	<i>Surg Today</i>	Case report	1
Oki <i>et al</i> ^[26]	2011	<i>Surg Today</i>	Retrospective study	10
Yoon <i>et al</i> ^[25]	2011	<i>Eur J Cardiothorac Surg</i>	Retrospective study	10
Bamba <i>et al</i> ^[24]	2010	<i>Surg Endosc</i>	Retrospective study	25
Zygoń <i>et al</i> ^[37]	2010	<i>BMJ Case Rep</i>	Case report	1
Osumi <i>et al</i> ^[23]	2009	<i>Endoscopy</i>	Retrospective study	7
Motoyama <i>et al</i> ^[22]	2006	<i>Ann Thorac Surg</i>	Case report	2
Yamashita <i>et al</i> ^[21]	2006	<i>Dig Liver Dis</i>	Case report	1
Atmani <i>et al</i> ^[20]	2006	<i>Dis Esophagus</i>	Case report	2
Okamoto <i>et al</i> ^[19]	2004	<i>Ann Thorac Surg</i>	Retrospective study	8
Akita <i>et al</i> ^[18]	2004	<i>J Surg Oncol</i>	Retrospective study	5
Ikeda <i>et al</i> ^[17]	2003	<i>J Thorac Cardiovasc Surg</i>	Case report	1
Lamblin <i>et al</i> ^[16]	2003	<i>Dis Esophagus</i>	Case report	3
Sugiura <i>et al</i> ^[5]	2002	<i>J Am Coll Surg</i>	Retrospective study	26
Shigemitsu <i>et al</i> ^[15]	2002	<i>Jpn J Clin Oncol</i>	Case report	5
Ben-nun <i>et al</i> ^[14]	2000	<i>Dis Esophagus</i>	Case report	1
Koyanagi <i>et al</i> ^[12]	1998	<i>J Gastroenterol Hepatol</i>	Case report	2

66.4%^[38]. Nonetheless, even at an early stage of GTC, endoscopic resection is difficult when the lesion is located on the staple line or pyloric ring, as was the case in our patient, and it may require a surgical approach with a higher risk of postoperative complications. Suzuki *et al*^[39] reported a high mortality rate (33%) for total resection of a reconstructed gastric tube after esophagectomy. Nonaka *et al*^[2] also reported a high mortality rate (23.8%) even in a high-volume Japanese cancer center.

A previous study reported that the frequency of nodal metastasis in GTC was 0% for intramucosal tumors and 10% for submucosal tumors^[24], such that LN dissection may be unnecessary for the vast majority of patients with early GTC. Generally, surgical gastrectomy with LN dissection is the standard treatment for early gastric cancer because there is a 1%-10% possibility of concurrent LN metastasis^[10]. However, elderly people are at higher risk of surgery-related death than are non-elderly patients, and the benefits of minimizing the risk of recurrence and metastasis in this group may be less profound. Therefore, if the estimated LN metastasis rate is lower than the 5-year mortality rate of a general cohort of the same age, surgery without LN dissection should be considered. In the present case, the swollen #6LN was resected but not checked by intraoperative pathological examination, because we had no plans to

perform radical LN dissection to prevent fatal complications (such as necrosis of the gastric tube) considering the status of the patient. Yagi *et al*^[7] reported that sentinel node biopsy could help avoid unnecessary LN dissection. However, it cannot be performed at every institution, nor has the accuracy of sentinel node biopsy been confirmed in patients undergoing gastrointestinal tract reconstruction including the gastric tube.

Preserving the blood supply of the remnant gastric tube is necessary for any partial resection of reconstructed gastric tube. LN dissection with resection of the distal gastric tube requires ligation of the RGEA and RGA, which can injure these vessels and cause ischemia in the lower and middle parts of the gastric tube. Yoshida *et al*^[40] reported two cases of resection of the distal part of the gastric tube, with dissection of the RGEA and RGEV, that required vascular reconstruction. Saito *et al*^[29] also reported two cases of subtotal gastric tube resection in which the RGEA and RGA were sacrificed based on an intraoperative indocyanine green evaluation of blood flow. In those cases, blood supply was re-established from the cervical esophagus for 5 cm until the proximal region of the gastric tube. However, vascular charge was needed during GJ. Additionally, operation time and blood loss were 538-783 min and 1490-2855 mL, both of which are considered highly invasive in elderly and/or high-risk patients. Therefore, the RGEA and RGA should be preserved during resection of the distal gastric tube in older or high-risk patients to prevent invasive surgery and fatal complications.

Some limitations of this study should be discussed. First, the observation period after the surgery was only 5 mo, although we continued to check for recurrence during additional follow-up visits. Thus, only the feasibility of the procedure could be demonstrated in this report. Second, the acceptable morbidity and mortality rates for prophylactic LN dissection are not clear but will vary depending on the patient's age, condition and attitudes about life and death, which will complicate surgical decision-making.

CONCLUSION

We suggest that resection of the distal gastric tube with preservation of the main trunk of the RGEA and RGA can serve as a safe surgical treatment for cT1bN0 GTC in elderly patients.

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