Successful robot-assisted minimally invasive surgery for scirrhous gastric conduit cancer after esophagectomy: A case report

KOICHI OKAMOTO[1], YUTA SANNOMIYA[1], KOKI FURUSE[1], KAORI MARUYAMA[1], HISASHI NISHIKI[1], AKIFUMI HASHIMOTO[1], DAISUKE KAIDA[1], TAKASHI MIYATA[1], TOSHIKATSU TSUJI[2], HIDETO FUJITA[1], NORIYUKI INAKI[2], SHINICHI KINAMI[1,3], ITASU NINOMIYA[4] and HIROYUKI TAKAMURA[1]

[1]Department of General and Digestive Surgery, Kanazawa Medical University Hospital, Kahoku, Ishikawa 920-0293, Japan; [2]Department of Gastrointestinal Surgery, Kanazawa University Hospital, Kanazawa, Ishikawa 920-8641, Japan; [3]Department of General and Digestive Surgery, Himi Principal Hospital Kanazawa Medical University, Himi, Toyama 935-8531, Japan; [4]Department of Surgery, Fukui Prefectural Hospital, Fukui, Fukui 910-0846, Japan

Received December 14, 2024; Accepted April 8, 2025

DOI: 10.3892/ol.2025.15083

Abstract. Patients with reconstructed gastric conduit cancer following esophageal cancer surgery can be treated through gastric conduit resection and regional lymph node dissection for pathological R0 resection. However, these procedures are difficult owing to the adhesions and scars around the gastric conduit and anatomical irregularities. To the best of our knowledge, robotic resection for scirrhous gastric conduit cancer occurring along almost the entire reconstructed gastric conduit has not been reported in the literature to date. The present study report the case of a 69-year-old man who underwent radical robot-assisted surgery for advanced gastric conduit cancer along most of the gastric conduit with regional lymph node metastases. The patient had previously undergone robot-assisted thoracoscopic esophagectomy and posterior mediastinal gastric conduit reconstruction for thoracic esophageal cancer at another hospital. Subsequently, 5 years later, the patient underwent esophagogastroduodenoscopy for a passage disorder, during which an elevated lesion with severe stenosis was found at the esophagogastric anastomosis, along with mucosal irregularity along the reconstructed gastric conduit that was then pathologically diagnosed as poorly differentiated adenocarcinoma. Thereafter, the patient was referred to Kanazawa Medical University Hospital (Kahoku, Japan) where he underwent robotic intrathoracic surgery. Forceps manipulations under a three-dimensional magnified view were conducted to dissect the adhesions around the lung, chest wall, tracheal membranous portion and reconstructed gastric conduit. Curative total remnant gastrectomy with lymph node dissection and digestive-tract reconstruction using a pedicled jejunum were conducted without severe intraoperative injuries. Pathological analysis of the resected specimen indicated scirrhous gastric conduit cancer originating along the gastric conduit with marked full-thickness fibrosis and clusters of adenocarcinoma cells. No obvious cancer remnants were found on the dissected surface of the subserous layer of the gastric conduit. After postoperative adjuvant chemotherapy with oral tegafur/gimeracil/oteracil and intravenous docetaxel for 4 months, the patient was alive without recurrence at 9 months postoperatively.

Correspondence to: Dr Koichi Okamoto, Department of General and Digestive Surgery, Kanazawa Medical University Hospital, 1-1 Daigaku, Uchinadamachi, Kahoku, Ishikawa 920-0293, Japan
E-mail: kokamoto@kanazawa-med.ac.jp

Abbreviations: SCC, squamous-cell carcinoma; GCC, gastric conduit cancer; CT, computed tomography; EBD, endoscopic balloon dilation; ESD, endoscopic submucosal dissection; HP, *Helicobacter pylori*; ICG, indocyanine green; LN, lymph-node; OS, overall survival; RAMIE, robot-assisted minimally invasive esophagectomy

Key words: robotic surgical procedures, robotics, adenocarcinoma, scirrhous gastric cancer, esophagectomy, remnant gastric cancer, gastric conduit cancer

Introduction

The occurrence of squamous-cell carcinoma (SCC) in the oral cavity, larynx, trachea, lungs, and residual esophagus as metachronous malignancies after esophageal cancer surgery is crucial from a clinical perspective. A history of heavy drinking and/or smoking, presence of oral flora, and preoperative presence of periodontal disease are reported as strongly relevant factors (1-3). Conversely, gastric conduit cancer (GCC) after digestive reconstruction often occurs due to chronic inflammation caused by preoperative *Helicobacter pylori* (HP) infection, patients' lifestyle, postoperative bile and intestinal juice reflux, and resulting intestinal metaplasia (1-5). Cases detected in the early stage can be treated via endoscopic submucosal dissection (ESD); however, in cases with advanced or widespread cancer, surgical gastric conduit resection with lymph-node (LN) dissection around the residual stomach and digestive tract reconstruction are required (6-14).

Robot-assisted minimally invasive esophagectomy (RAMIE) has recently been gaining global popularity as a high-definition, high-quality radical surgery that uses robotic technology for minimally invasive esophagectomy (8). Robot-assisted surgery (RAS) provides several advantages, such as a three-dimensional (3D) magnified view, high degree of freedom for surgical maneuvers, and reduced misses due to hand tremors, allowing easier, more precise, and gentle manipulation that is required for intrathoracic esophageal resection and mediastinal LN dissection (15-19). These advantages may also prove effective for adhesion dissection that is required for gastric conduit resection, avoidance of collateral damage to important organs, and accurate recognition of modified anatomy in reoperation cases.

Here, we report a case with metachronous scirrhous GCC originating along the entire conduit, which was safely and radically resected by robot-assisted transthoracic surgery.

Case report

A 69-year-old Japanese man had undergone RAMIE for thoracic esophageal SCC without synchronous gastric cancer 5 years ago. The surgical procedure involved complete mediastinal LN dissection and esophagectomy in the left-lateral position, abdominal LN dissection, and gastric conduit creation. Cervical LN dissection was omitted for minimal invasiveness. For gastrointestinal reconstruction, a gastric conduit was created via the posterior mediastinal route, and esophagogastric anastomosis was performed at the cervical site. Postoperatively, pneumonia and respiratory failure occurred, necessitating temporary tracheotomy. A pathological diagnosis of multiple early esophageal cancers was made [1) Mt, 10x10 mm, SCC, pType 0-IIc, INFb, ly1, v0, pIM0, pT1a-MM; 2) Mt, 5x3 mm, SCC, pType IIb, pTis, pN0 (0/48), M0, pStage 0, pPM0, pDM0, pRM0, D2, Cur A]. Curative resection was performed (Fig. 1). Postoperatively, anastomotic stenosis occurred repeatedly, requiring multiple endoscopic balloon dilation (EBD) procedures over the 5-year follow-up period. Although the patient was a habitual drinker and smoker preoperatively, he abstained from alcohol and smoking after esophageal cancer surgery. He had already undergone HP eradication therapy successfully before the primary RAMIE for esophageal SCC.

Five years after surgery, he presented with the digestive passage disorder. Esophagogastroduodenoscopy (EGD) performed at Kanazawa University Hospital (Kanazawa, Japan) revealed circumferential stenosis at the esophagogastric anastomosis, for which EBD was repeated. Retrospectively, no obvious tumor lesion was observed at the esophagogastric anastomosis and remnant stomach in the annual screening endoscopic findings from one year before the cancer diagnosis (Fig. 2A and B). An 0-I-type elevated lesion protruding into the lumen was observed on the posterior wall of the anastomotic site (Fig. 2C and D); consequently, a biopsy was performed, indicating a poorly differentiated carcinoma. The patient was thereafter referred to our hospital, Kanazawa Medical University Hospital (Kahoku, Japan), for further examination and treatment. On repeat EGD, we observed diffuse mucosal hardening, disappearance of folds, and redness from the upper part to the antrum of the reconstructed gastric conduit (Fig. 2E and F). Further, specimens from several sites along the gastric conduit were biopsied, and histopathological findings revealed poorly differentiated carcinomas in all specimens. Immunohistochemical staining revealed strong AE1/3 and carcinoembryonic antigen (CEA) positivity, supporting a diagnosis of adenocarcinoma (por-tub2). Fluorography indicated anastomotic stenosis with a wall irregularity. The expansion of the gastric conduit was poor because of the wall hardness (Fig. 2G). On contrast-enhanced computed tomography (CT), diffuse wall thickening was noted along the entire reconstructed gastric conduit along with mediastinal LN enlargement (Fig. 3A-C). ^{18}F-fluorodeoxyglucose (^{18}F-FDG) positron emission tomography indicated faint abnormal ^{18}F-FDG accumulation in the wall of the reconstructed gastric conduit (Fig. 3D and E). No obvious distant metastasis, pleural effusion, or ascites was observed.

According to the 15th edition of the Japanese classification of gastric carcinoma (20), all the above findings indicated advanced gastric scirrhous carcinoma [M-5-TE, circ, adenocarcinoma (tub2-tub1), cType 4, 170 mm, cT3N2M0P0CYX cStage IIIA] originating along almost the entire reconstructed gastric conduit with esophageal infiltration. Thereafter, we planned to perform gastric conduit resection and mediastinal LN dissection through RAS as a curative treatment.

Surgical procedure. We planned to perform a radical surgery using the DaVinci Xi Surgical System that allows RAS to be conducted with the patient in a prone position. The first port was carefully inserted during intrathoracic manipulation, and the extensive intrathoracic adhesions between the lung surface and chest wall were carefully dissected via thoracoscopic and robotic manipulation; thereafter, the remaining ports were inserted and the robot setup was completed. Cytological examination of the pleural lavage was negative for cancer cells. However, the patient's respiratory function was poor because of coexisting chronic obstructive pulmonary disease; therefore, bilateral lung ventilation was performed. The hard adhesions between the lung surface, reconstructed gastric conduit, and membranous portion of the trachea were dissected under 3D magnified observation (Fig. 4A-D). Using the third robotic arm's forceps to maintain a good surgical field, the right lung was gently compressed with using gauze (Fig. 4B). The reconstructed gastric conduit could not be grasped because of diffuse wall hardening and thickening, so we tried to secure the dissection layer under 3D magnified observation using an appropriate counter traction with repeated changing of the third-arm compression points. Minute traumatic injuries to the lung surface resulting in air leakage were repaired with sutures each time. Hard scarring also was observed around the esophagogastric anastomosis, probably due to repeated EBD procedures; hence, precise tracing of the excisional line was needed to expose the contours of the surrounding adherent organs (Fig. 4E). Consequently, there was no clear exposed cancer tissue on the serosal surface of the reconstructed gastric conduit and it could be resected without any visible remnant tumor. This was accompanied by LN dissection around the right-gastroepiploic artery and right-gastric

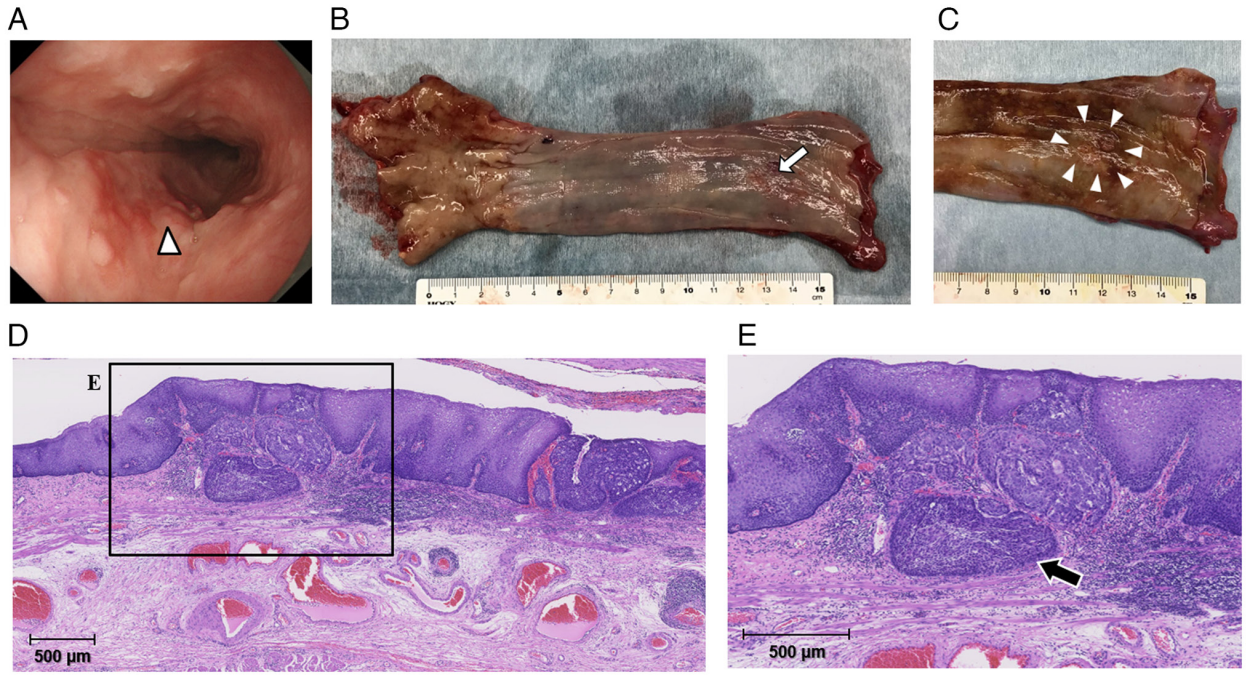

Figure 1. Preoperative endoscopic findings, resected primary esophageal cancer image and histopathological microscopy findings of the resected specimen. (A) Preoperative endoscopic examination revealing a reddish Type 0-IIc lesion in the middle thoracic esophagus (white arrowhead). (B) Esophagectomy specimen with a superficial cancer lesion (length, 1.0 cm; white arrow). (C) Superficial cancer lesion appearing as an unstained area after iodine staining (white arrowheads). (D) Microscopy images of the squamous-cell carcinoma lesion localized to the lamina propria in the middle thoracic esophagus (black square). (E) Well-differentiated squamous-cell carcinoma cells with lymphatic invasion mainly distributed in the mucosa and lamina propria (black arrow) (scale bars, 500 μm).

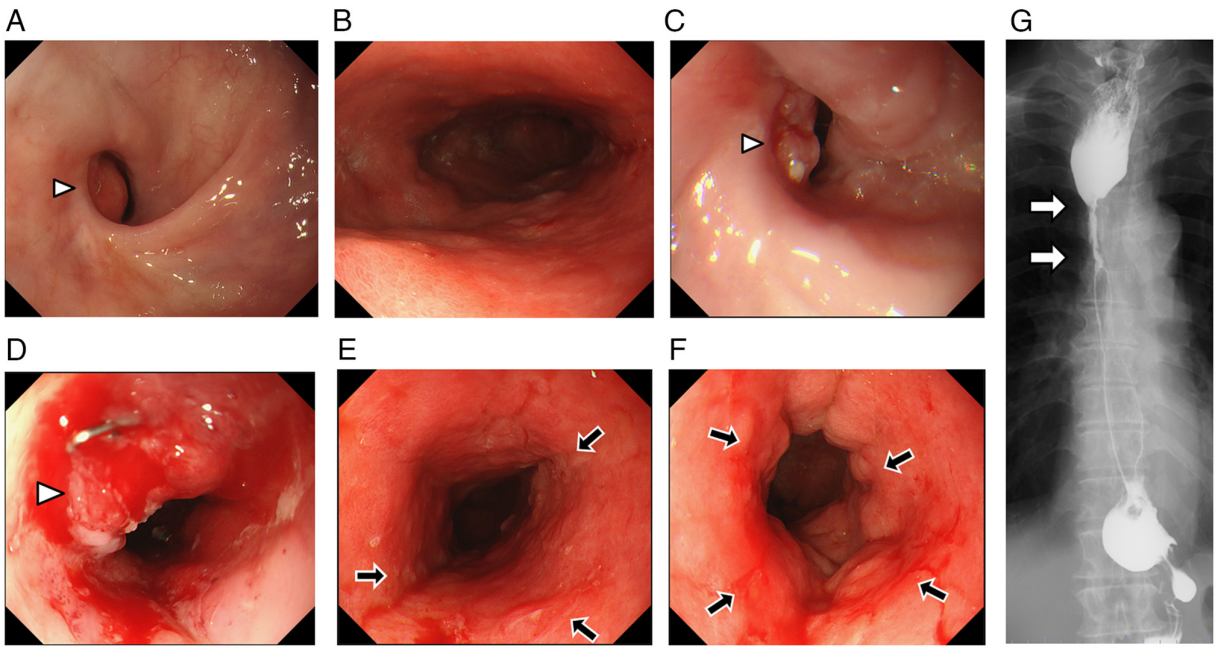

Figure 2. Preoperative imaging findings. (A and B) Esophagogastroduodenoscopy showing no elevated or stenotic lesion in the esophagogastric anastomosis (white arrowhead) and the remnant stomach before a year of the diagnosed timing. (C) Esophagogastroduodenoscopy findings of an elevated lesion with apparent stenosis in the esophagogastric anastomosis part (white arrowhead). (D) Circumferential mucosal roughness and wall hardening visible in the middle of the reconstructed gastric conduit (white arrowhead). (E and F) Circumferential mucosal thickness without apparent stenosis observed along the anal edge of the lower gastric conduit (black arrows). (G) Esophagogastric image showing a 4-cm circumferential stricture from the entrance of the esophagogastric anastomosis to the lower gastric conduit (white arrows).

artery without injuring the tracheal membranous portion, anterior surface of the descending aorta, or pericardium. At the upper-mediastinal level, the ZEOCLIP® (Zeon Medical, Tokyo, Japan) marked on the oral side of the tumor was identified using indocyanine green (ICG) fluorescence, and an automatic stapler was used to resect the remaining

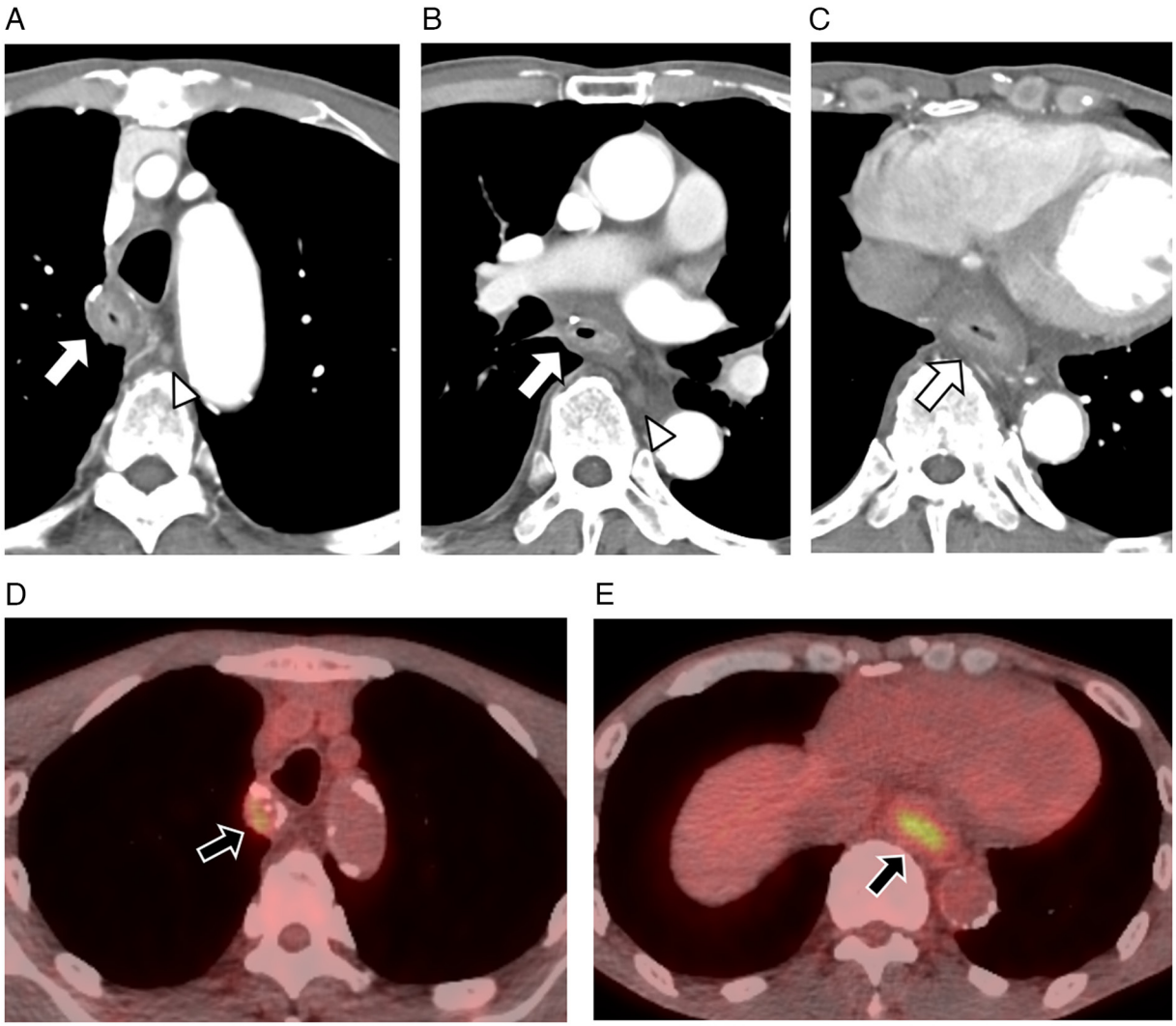

Figure 3. Preoperative CT and positron-emission tomography imaging findings. (A) Upper gastric conduit. (B) Middle gastric conduit. (C) Lower gastric conduit. Preoperative CT image showing the wall thickness along most of the gastric conduit (white arrows). Multiple swollen lymph nodes visible around the reconstructed gastric conduit (white arrowheads). (D and E) Abnormal ^{18}F-fluorodeoxyglucose uptake visible throughout most of the thickened gastric conduit wall (black arrows). CT, computed tomography.

esophagus on the oral side of the ZEOCLIP® (Fig. 4F). The intrathoracic operation time, console time, and blood loss were 498 min, 439 min, and 520 g, respectively.

Abdominal manipulation involved gastric conduit resection and LN dissection, with transection of the right-gastroepiploic and right-gastric arteries and veins, followed by extraction of the resected specimen. The small intestine and right colon mesentery was then dissected and mobilized from the retroperitoneum, securing it such that the pedicled jejunum could be elevated to the neck. For digestive reconstruction, the pedicled jejunum was elevated via an anterior-thoracic subcutaneous route in the anterior chest, and a circular stapler was used to perform end-to-side esophagojejunal anastomosis. Blood flow evaluation using ICG fluorescence and Doppler monitoring confirmed that there was no ischemia or congestion in the reconstructed jejunum; therefore, additional revascularization procedures, such as supercharge and superdrainage, were not performed. The overall intraoperative time was 871 min and the total blood loss was 860 g.

Histological findings of the resected specimens. Macroscopically, the resected residual esophagus and gastric conduit exhibited continuous wall thickening and hardening from the esophagogastric anastomosis to almost the entire gastric conduit (Fig. 5A). Histologically, the gastric conduit exhibited notably broad and thick proliferation of fibrous scar tissue along most of the stomach wall, except for the area near the pylorus (Fig. 5B). In addition, adenocarcinoma cells were diffusely and noncohesively scattered in and under the mucosa along most of the gastric conduit and had also infiltrated into the resected residual esophageal wall (Fig. 5C-E) but no cancer cells were present at the oral resection edge. The serosa of the resected gastric conduit had been peeled off during the surgery, but no obvious cancer cells were exposed on the surface. The deepest part of the cancer tissues invaded the subserous layer of the stomach. Apparent metastases were evident in multiple dissected perigastric and intra-abdominal LNs (Fig. 5F). Immunohistochemical staining was negative for squamous epithelial markers p40 (Fig. 6C) and CK5/6 (Fig. 6D) in the cancerous area but positive for CEA (Fig. 6A)

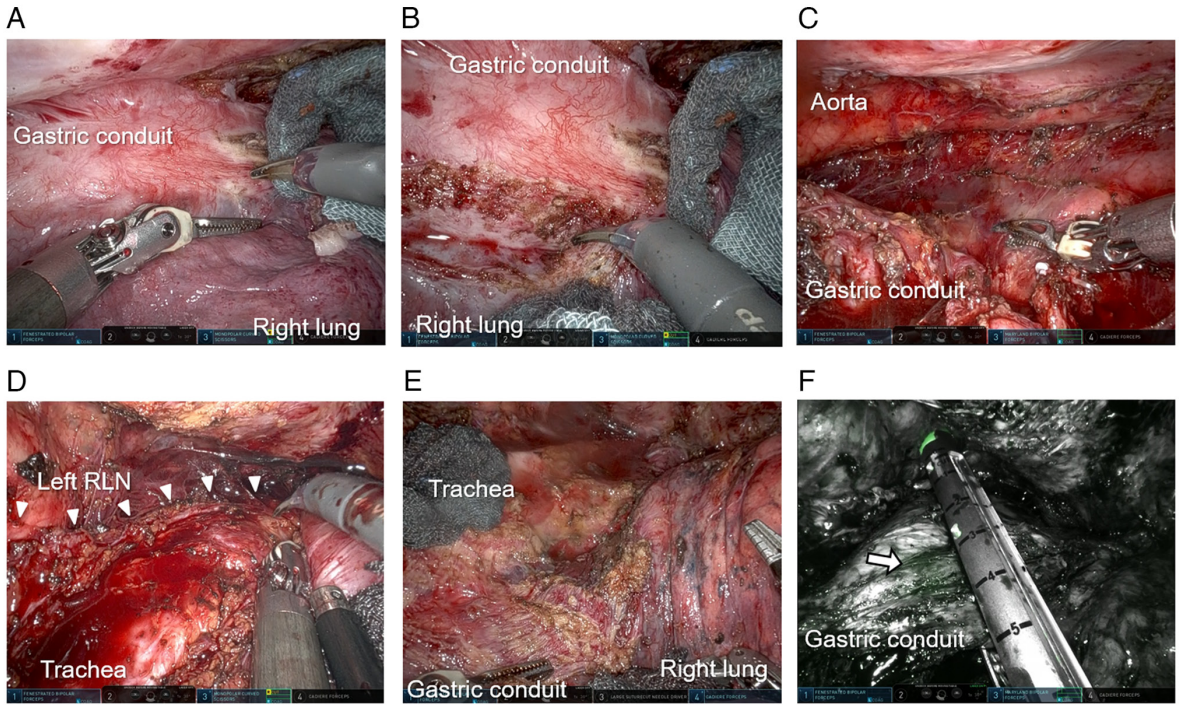

Figure 4. Intraoperative view of the intrathoracic part. (A) Robotic manipulation was performed to carefully dissect the extensive hard adhesions between the lung surface and reconstructed gastric conduit. (B) Using the robotic forceps, the right lung was gently compressed with using gauze. Sharp or blunt dissection of the hard adhesions between the lung surface and the reconstructed gastric conduit in a 3D magnified view. (C) The hard adhesions between the anterior wall of the descending aorta and reconstructed gastric conduit could be dissected without traumatic injury or bleeding. (D) The left recurrent laryngeal nerve was carefully preserved along its entire length, and dissection of the surrounding organs was completed (white arrowheads). (E) Hard scarring visible around the esophagogastric anastomosis, probably caused by repeated endoscopic balloon dilation. Robotic manipulation was performed to dissect the hard adhesions between the membranous portion of the trachea and reconstructed gastric conduit. (F) At the upper mediastinal level, a ZEOCLIP® was attached to the oral side of the tumor at the remaining esophagus, which was identified through indocyanine green fluorescence staining, and an automatic stapler was used to resect the remaining esophagus on the oral side.

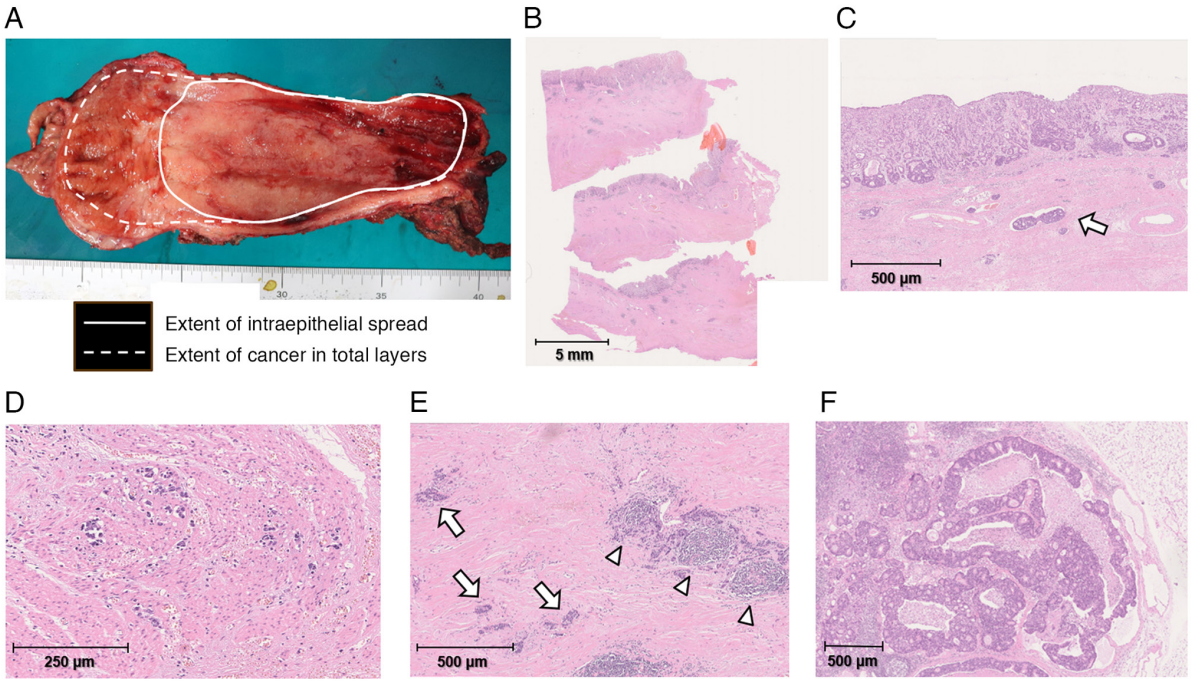

Figure 5. Gross and histopathological findings. (A) Resected residual esophagus and gastric conduit with continuous wall thickening and hardening from the esophagogastric anastomosis along almost the entire gastric conduit. The solid line indicates the extent of the intraepithelial spread of the cancer, and the dotted line indicates the extent of the cancer across all layers of the remnant stomach. (B) Loupe image of the resected specimens (scale bar, 5 mm). (C) Adenocarcinoma cells distributed throughout the lamina propria of the resected gastric conduit. Evident lymphatic invasions into the submucosal tissue also visible (white arrows) (scale bar, 500 μm). (D) Adenocarcinoma cells noncohesively scattered under the submucosal layer of the gastric conduit (scale bar, 250 μm). (E) Small cancerous nests (white arrowheads) or vascular invasion (white arrows) widely distributed throughout the gastric conduit (scale bar, 500 μm). (F) Apparent metastases of tubular adenocarcinoma cells evident in the dissected perigastric lymph nodes (scale bar, 500 μm).

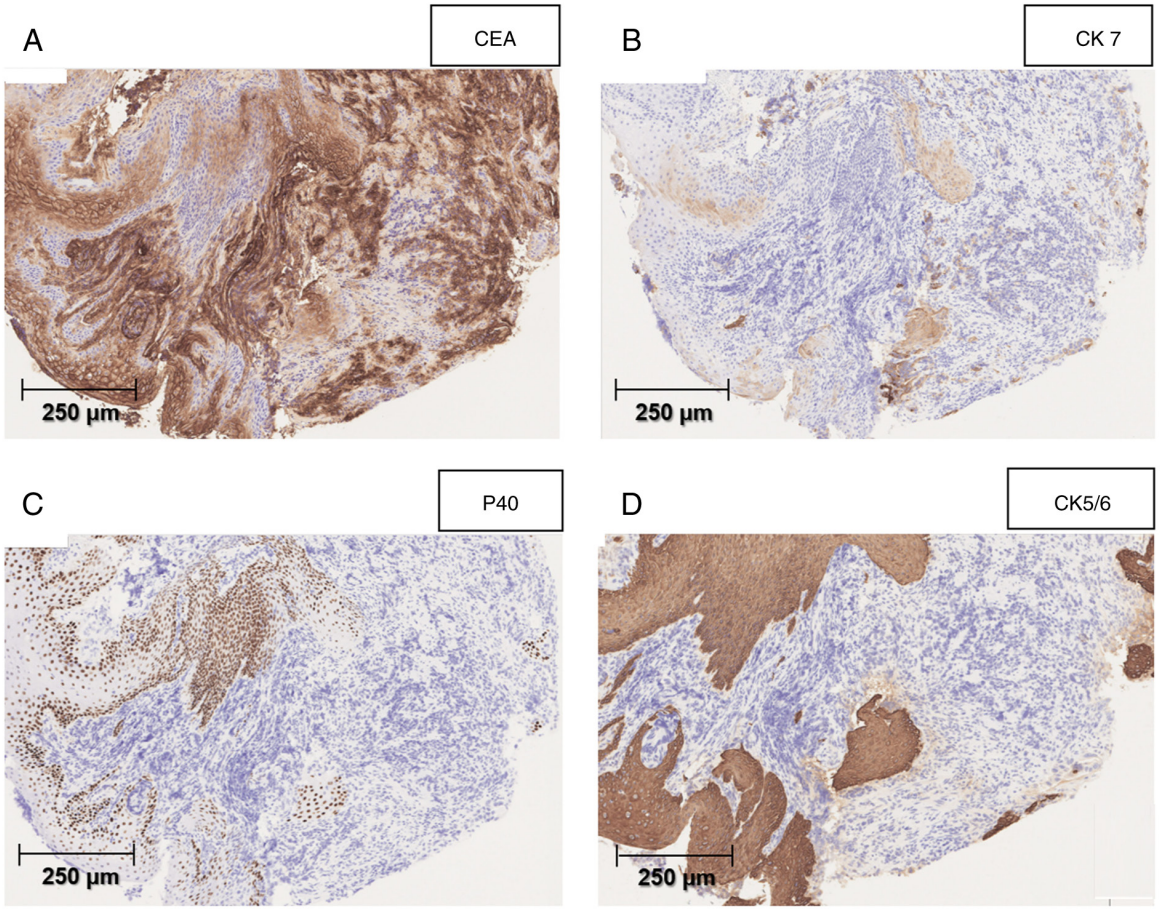

Figure 6. Immunohistochemical staining of the resected specimens: (A) Positive for CEA and (B) CK7 and negative for the squamous epithelial markers (C) p40 and (D) CK5/6 in the cancerous area. These findings are characteristic of adenocarcinoma (scale bars 250 μm). CEA, carcinoembryonic antigen; CK, cytokeratin.

and CK7 (Fig. 6B); these findings are characteristic of adenocarcinoma.

Finally, the pathological diagnosis was remnant scirrhous gastric cancer originating along most of the gastric conduit [M-5-TAE, circ, 203x76 mm, pType 4, moderate-to-well-differentiated adenocarcinoma (tub2-tub1), pT3, INFc, Ly1b, VX, pIM0, pPM0, pDM0, pN3(7/22, #4sax4, #4sbx1, #6x2) M0, CY0, P0, pStage IIIC, D2, Cur A] (20). Surgical treatment resulted in pathological curative resection.

Postoperative clinical course. The patient presented with a minor anastomotic leakage at the esophagojejunostomy and pneumonia; both were successfully resolved through conservative management. Subsequently, he was discharged on postoperative day 47. Given the substantial risk of recurrence, the patient underwent adjuvant chemotherapy with oral tegafur/gimeracil/oteracil (oral 5-fluorouracil prodrug) and triweekly docetaxel for 4 months after the prescribed protocol for adjuvant chemotherapy in gastric cancer (21,22). He remained relapse-free, as shown by periodic CT examinations, and was alive at postoperative 9 months.

Discussion

To the best of our knowledge, this is the first case report on the use of minimally invasive robotic procedure for the successful treatment of scirrhous gastric carcinoma originating in the reconstructed gastric conduit after esophageal cancer surgery.

The benefits of RAS include accurate recognition of microanatomy because of 3D magnification, precise robotic arm operation through the multi-joint function, image stabilization, and surgeon-centered surgical-field development using a third arm (23,24). RAS is also less physically demanding than laparoscopic surgery, which requires long-term static muscle activity with a high physical workload for surgeons (25). Studies comparing robotic vs. laparoscopic gastrectomy for gastric cancer, robotic vs. laparoscopic colectomy for colon cancer, and RAMIE vs. conventional thoracoscopic or open esophagectomy for esophageal cancer have reported that RAS is more useful in the treatment of malignant tumors in many cases (16,19,23,24,26,27).

Recently, thoracoscopic esophagectomy and RAMIE have become increasingly popular for the surgical treatment for resectable esophageal cancer. Warner *et al* (28) reported that thoracoscopic esophagectomy is acceptable in resectable cases after neoadjuvant CRT without evidence of increased morbidity or mortality. Mederos *et al* (16) and Tagkalos *et al* (29) reported the usefulness of RAMIE vs. conventional thoracoscopic or open esophagectomy for esophageal cancer. In addition, Defize *et al* (30) reported the usefulness of RAMIE as a salvage surgery after definitive chemoradiotherapy for unresectable advanced cancer with infiltration in other organs.

They reported that after definitive CRT, normal anatomical structures were restored in 75% of resectable cases, making resection without residual tissue possible. However, in cases where the border between the fibrosis and tumor was unclear, curative resection while recognizing the anatomical structures was challenging. Despite such surgical results, pathologically curative resection was achieved in 92% of cases, suggesting that RAMIE can ensure curability even in salvage surgery after CRT. Alhossaini *et al* (31) reported that in cases with remnant gastric cancer, RAS is less invasive than laparoscopic surgery in terms of the low rate of conversion to open surgery because of severe adhesions. A review of 10 nonrandomized controlled trials reported that compared with open gastrectomy, laparoscopic gastrectomy for remnant gastric cancer can lead to better short-term outcomes, including lower blood loss, lower postoperative complication rate, and shorter postoperative hospital stay. Although laparoscopic gastrectomy for remnant gastric cancer is technically complex, it is feasible, safe, and is minimally invasive. However, one report stated that conversion to open gastrectomy during laparoscopic gastrectomy is unavoidable in many patients with severe intra-abdominal adhesions and anatomical abnormalities (32).

In the present case, we opted for robotic remnant gastrectomy for a thorough and less invasive mediastinal LN dissection. Although RAMIE was conducted for the previous esophageal cancer, the right lung was firmly adhered to the chest wall, trachea, pericardium, and anterior surface of the aorta. The esophagogastric anastomosis and surrounding organs had developed hard cicatricial adhesions to the lungs and tracheal membranous portion after undergoing multiple EBD procedures; however, RAS enabled the detachment and resection of these adhesions without severe secondary injury. Moreover, using the robotic forceps to suture partially injured lung surfaces was also effective in tissue repair. Using all the advantages offered by RAS and by performing careful intrathoracic manipulations, the surgery was completed without any major intraoperative complications, although it was time-consuming. RAS may enable easy adhesion removal, provide accurate anatomical recognition, and be less invasiveness in patients with a history of laparotomy or thoracotomy.

Several reports have been published on the epidemiology, etiology, diagnostic methods, and treatment of GCC after esophageal cancer surgery. Lee *et al* (7) reported that the incidence rate of reconstructed GCC is 2.4% per 5 years and 5.7% per 10 years, and the average occurrence-to-diagnostic time is 55.8 months (4-236 months) after esophagectomy, with 92% histological types being adenocarcinoma. A nationwide study in Japan by Ota *et al* (13) reported that the proportion of early cancer (T1) was ~60% in primary gastric cancer but 81.5% in GCC, which is high. This may be because of the continued postoperative follow-up for patients with esophageal cancer and the accessibility of EGD in Japan (33,34). The median interval between esophagectomy and GCC diagnosis was 6 years, with ~25% of patients being diagnosed >10 years later. The 5-year overall survival (OS) rates after endoscopic and surgical treatments for GCC were 75.9 and 52.7%, respectively. In a study by Gentile *et al* (10), 41.6% of GCC cases were treated via endoscopic resection while avoiding gastric conduit resection. Close monitoring and long-term follow-up may be useful in the early detection of GCC and appropriate therapeutic intervention. Yearly endoscopic follow-up >10 years after esophageal cancer surgery has been recommended (9,10,13). However, in cases of resectable advanced cancer where early detection through meticulous screening is not possible, surgery is the only curative treatment.

The etiology of GCC includes chronic gastritis because of HP infection and subsequent intestinal metaplasia (35,36). Various other factors, such as relaxation of the pylorus ring due to vagotomy, decreased peristalsis of the gastric conduit, and intestinal metaplasia due to bile reflux caused by negative intrathoracic pressure, may be involved. Histologically, primary gastric cancer caused by chronic inflammation can be intestinal and well-differentiated (37). In this case, HP had been eradicated before the initial surgery, and the patient had chronic gastritis along with moderate mucosal atrophy; therefore, GCC onset at 5 years was probably earlier than the average. Palmes *et al* (38) reported that bile reflux can cause chronic inflammation and intestinal metaplasia in the reconstructed gastric conduit; therefore, pyloric drainage (pyloroplasty or pyloromyotomy) after esophagectomy with esophagogastrostomy and vagotomy are not recommended. In fact, in the present case, clear bile reflux was observed in the reconstructed gastric conduit during the annual screening EGD up to the previous year. Shirakawa *et al* (9) and Ota *et al* (13) reported that ~60% of GCC cases occurred in the lower third portion of the gastric conduit. In cases where GCC was of detected early through appropriate screening, endoscopic treatment in accordance with the indications for ESD for normal early gastric cancer can be expected to cure GCC in a less invasive manner (8,11,14,39). Furthermore, abstinence from alcohol and smoking after treatment for initial esophageal cancer significantly reduces the incidence of pharynx and laryngeal, oral, and residual esophageal cancers (1,2,4); however, GCC occurred in this case despite strict abstinence from alcohol and smoking since the initial esophageal cancer diagnosis.

Gastric cancer with histological findings of signet ring-cell carcinoma or poorly differentiated adenocarcinoma tends to have an unclear border, exhibits diffuse infiltration, and is often accompanied by significant fibrosis within the wall; therefore, it is called scirrhous gastric cancer. Macroscopically, it is often classified as type 4 and is characterized by hardening and thickening of the wall (40). Compared with other macroscopic types, type-4 gastric cancer is more likely to disseminate peritoneally. This type of cancer is also characterized by the absence of protuberances, depressions, or ulcers in the shape of the tumor, wall hardening, and slow progression, making a qualitative or extensive diagnosis difficult. Histologically, scirrhous gastric cancer is often diffuse and poorly differentiated (por, sig), and chronic gastritis and intestinal metaplasia may not necessarily be present in the background (26,32). In the present case, EGD was performed to examine the wall hardening and the esophagogastric conduit anastomosis stenosis, which indicated the presence of a lesion. However, it cannot be denied that GCC did not exist at that time. Therefore, it is necessary to be fully aware that scirrhous GCC presents as a stenotic lesion with an unclear border, and to consider performing a biopsy if necessary. The primary lesion in the gastric conduit extended not only to the upper stomach but was also accompanied by extensive infiltration of most of the

gastric conduit. However, we could not accurately diagnose the extent of the lesion preoperatively. Furthermore, the resected specimen did not include signet ring cells, and the histological type was a mixture of tubular and poorly differentiated adenocarcinoma. At Kanazawa University Hospital where the initial histological diagnosis was made, the diagnosis was not definitively made as adenocarcinoma, but was confirmed by immunostaining in Kanazawa Medica University Hospital. In fact, because only a small portion of the tumor was collected in the biopsy tissue, it is possible that the cancer cells scattered within the fibrous tissue were misdiagnosed as poorly differentiated cancer. Moreover, EBD had been performed multiple times for anastomotic stenosis before the diagnosis of GCC. No obvious tumor lesion was observed at the esophagogastric anastomosis on annual endoscopic screening from the year before the cancer diagnosis (Fig. 2A and B). However, it cannot be confirmed if GCC was present at that time. Therefore, it is necessary to consider that scirrhous GCC can present as a stenotic lesion with an unclear border, and a biopsy should be conducted if necessary. Preoperative images suggested advanced GCC with invasion deeper than the muscular propria layer, and multiple perigastric LN metastases were suspected in the area of the right-gastroepiploic artery, the nutrient vessel of the reconstructed gastric conduit. A nationwide study in Japan reported that the degree of LN metastasis in GCC was strongly associated with prognosis (13). This finding suggests that adequate LN dissection of the gastric conduit basin is necessary in curative GCC surgery. As a result, total resection of the residual esophagus and reconstructed gastric conduit and a thorough regional LN dissection is unavoidable for radical resection. However, given the need for thorough perigastric LN dissection, we consider RAS to be extremely useful in this case.

The pathological diagnosis of the resected specimen was T3N3M0 pStage IIIC. Although robotic resection was considered to be curative, the risk of recurrence was high, leading to DS therapy with docetaxel and S-1 being administered as adjuvant chemotherapy. The JACCRO GC-07 study was a randomized phase-III study that aimed to determine whether adjuvant chemotherapy with DS therapy in pStage-II-III advanced gastric cancer was superior to S-1 alone (21,22,41). DS therapy resulted in a significantly better 3-year relapse-free survival [hazard ratio (HR), 0.632; S-1 plus docetaxel, 65.9%; S-1 alone, 49.5%; P<0.001], and is a commonly used regimen in Japan (22). In addition, the JACCRO GC-07 study reported a better 5-year OS in patients with pathological stage-III gastric cancer treated with DS therapy (HR, 0.752; S-1 plus docetaxel, 67.9%; S-1 alone, 60.3%; P=0.0059) (41). In this case, DS therapy was discontinued at the patient's request after 4 months of treatment. Strict follow-up is necessary as the risk of peritoneal dissemination, pleural dissemination, and LN recurrence is very high as in scirrhous gastric cancer.

The reconstructive route used in prior esophagectomy may influence the success of radical resection for GCC. Koyanagi *et al* (42) reported a resection rate of 50% in cases where the posterior mediastinal route was used, 77% for those using the retrosternal route, and 93% for those using the anterior-thoracic route. In general, secondary cancers were detected easily in cases with anterior-thoracic route reconstructions, and the operative procedure was less difficult than in those by other routes. Thus, the resection rate was better with the anterior-thoracic reconstruction route than for the other routes (42). Fujisawa *et al* (43) recently reported a study where transabdominal gastric conduit resection was conducted for metachronous GCC in a gastric conduit reconstructed via a retrosternal route. RAS should be considered to be a useful option, even in cases with severe scar changes, postoperative adhesions, and modified anatomy in reoperation cases.

In summary, we report a rare case of scirrhous GCC originating in the reconstructed gastric conduit after esophageal cancer surgery that was successfully treated through minimally invasive RAS with radical transthoracic and gastric conduit resection and regional LN dissection. Even in cases of reoperation for GCC, RAS can be safely used to perform appropriate radical surgery while minimizing secondary damage, making it a useful option that improves the feasibility of difficult surgeries.

Acknowledgements

Not applicable.

Funding

No funding was received.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Authors' contributions

KO conceived this case presentation and drafted the manuscript. KO, KF, KM, YS, HN and AH performed the surgery and therapeutic management of the patient. KO, TT, NI and IN managed the previous esophageal cancer surgery of the patient. DK, TM, HF, SK and HT contributed to the acquisition of data, interpretation of data and editing of the report. KO and HT confirm the authenticity of all the raw data. All authors read and approved the final manuscript.

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Written informed consent was obtained from the patient for the publication of this case report and the accompanying images.

Competing interests

The authors declare that they have no competing interests.

Use of artificial intelligence tools

During the preparation of this work, AI tools were used to improve the readability and language of the manuscript or to generate images, and subsequently, the authors revised and edited the content produced by the AI tools as necessary,

taking full responsibility for the ultimate content of the present manuscript.

Authors' information

KO, NI and IN are specialists and instructors of the Japanese Society of Gastroenterological Surgery and the Japanese Esophageal Society, and serve as councilors of the Japanese Esophageal Society.

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