MEGA JOURNAL OF CASE REPORTS

OPEN ACCESS

Research Article

Compiled Date: January 18, 2025

Robotic Proximal Gastrectomy with Totally Intracorporeal Kamikawa Anastomosis: Technical Details and Short-Term Outcomes

Chengcai Liang[1,2#], Jianrong Guo[1,2#],Yuan Qi[1,2#] and Shuqiang Yuan[1,2*]

[1]State Key Laboratory of Oncology in South China, Guangdong Provincial Clinical Research Center for Cancer, Collaborative Innovation Center for Cancer Medicine, Sun Yat-sen University Cancer Center, Guangzhou, Guangdong, China

[2]Department of Gastric Surgery, Sun Yat-sen University Cancer Center, Guangzhou, Guangdong, China

[#]These authors contributed equally to this work.

[*]**Corresponding author**: Shuqiang Yuan, 651 Dong Feng Road East, Guangzhou 510060, China, Tel: +86-18565425502; Fax: +86- 020-87343392

Abstract

Background: Kamikawa anastomosis is a novel esophagogastrostomy technique with a superior anti-reflux effect. However, due to its complex suturing and ligation maneuvers, this method remains technically challenging to perform through totally minimally invasive surgery.

Methods: Recently, we successfully performed robotic proximal gastrectomy (RPG) with totally intracorporeal Kamikawa anastomosis in a 66-year-old male patient diagnosed with adenocarcinoma of the esophagogastric junction (EGJ). Here, we present the surgical details and outcomes of this operation.

Results: The operation was completed successfully, with a total operative time of 220 minutes, including 55 minutes for the anastomosis. Estimated blood loss was only 150 cc. The patient was discharged on postoperative day 8 without any perioperative complications, indicating an uneventful postoperative recovery. Postoperative gastrointestinal radiography at one month after surgery typically demonstrated

unobstructed esophagogastrostomy, with no evidence of anastomotic fistulas or luminal narrowing.

Conclusion: This is the first reported case of RPG with totally intracorporeal Kamikawa reconstruction. Our experience suggests that this procedure might be feasible and safe for selected patients with upper-third gastric cancer or EGJ cancer.

Keywords: Robotic proximal gastrectomy (RPG); Kamikawa anastomosis; Gastric cancer; Surgical details; Perioperative outcomes

Introduction

Proximal Gastrectomy (PG), a function-preserving procedure, has been increasingly recommended for patients with upper-third gastric cancer or Esophagogastric Junction (EGJ) cancer, especially those at early stages **[1,2]**. Several reconstruction procedures can be employed after PG, including esophagogastrostomy, jejunal interposition and double tract reconstruction. Each of these reconstruction methods has its advantages and disadvantages, and the optimal procedure has not yet been established **[3,4].** Among these procedures, esophagogastrostomy has been commonly performed due to its simplicity, whereas it carries a higher risk of reflux esophagitis, which can result in poor quality of life **[5-8].**To address this issue, Kamikawa et al. **[6]** developed a novel esophagogastrostomy with Double-Flap Technique (DFT) in 2001, also known as Kamikawa anastomosis. Achieved by burying the abdominal esophagus into the gastric double seromuscular flaps, Kamikawa anastomosis is a hand sewn esophagogastrostomy with good anti-reflux effect and several other advantages **[6,9,10]**. Nowadays, this potentially ideal reconstruction method has been applied to laparoscopic and robotic-assisted PG **[5-8,10-15].** Nevertheless, owing to complicated suturing and ligation maneuvers, this method is still technically difficult to perform through totally Minimally Invasive Surgery (MIS). In this setting, we recently performed a case of Robotic PG (RPG) with totally intracorporeal Kamikawa anastomosis. Hereby we reported the surgical details and outcomes of this operation.

Materials and Methods

Patient selection

The patient was a 66-year-old male with a body-mass index of 20.8 kg/m2. **Figure 1** summarizes the tumor characteristics from key examinations. As depicted, his primary diagnosis was adenocarcinoma of EGJ, Siewert type III, cT2~3N0M0.Informed consent was obtained prior to the operation. Professor Shuqiang Yuan, who having finished over 100 robotic gastrectomy and several hundred laparoscopic gastrectomy, performed this operation via the da Vinci Xi robotic system on January 17, 2024.

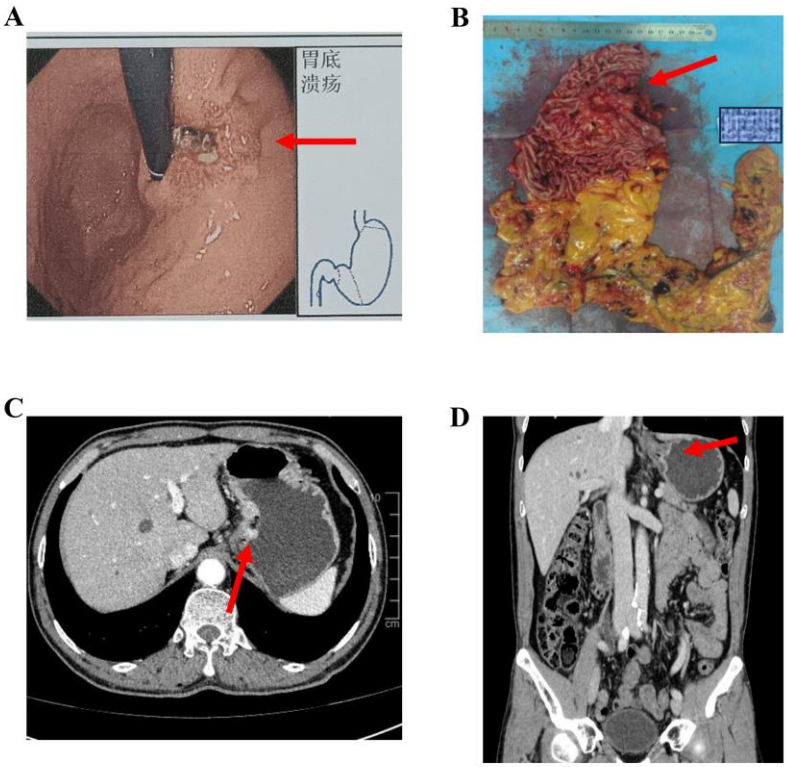

Figure 1: Tumor characteristics. A) Gastroscopy revealed a 25-mm ulceration at the posterior wall of the gastric fundus and near to the cardia; B) Postoperative gross specimen confirmed an invasive ulceration located at the gastric fundus and near to the cardia, measuring approximately 30*28 mm and demonstrating no significant evidence of serosal invasion; C~D) preoperative enhanced CT showed14-mm thickening of the gastric wall at the gastric fundus and extending to the lesser curvature, without obvious enlarged peri-gastric lymph nodes.

Operative technique

After general anesthesia, the patient was placed in a modified 30° tilt-down lithotomy position, with the legs apart and flexed slightly. The assistant surgeon (Chengcai Liang) was positioned between the patient's legs. **Figure 2** demonstrates the location of trocars and placement of robotic instruments. Pneumoperitoneum was established through Port 0 and the abdominal pressure was maintained at 12~14 mmHg.

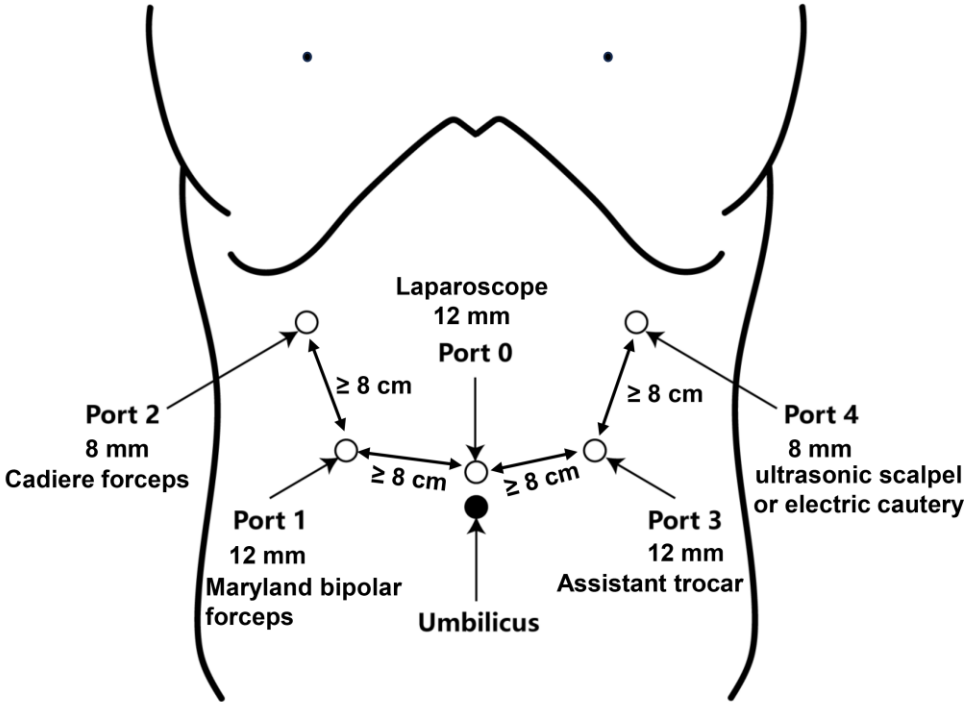

Figure 2: Location of trocars and the placement of robotic instruments. Port 0: an 8-mm robotic trocar for placement of the laparoscope; Port 1: a 12-mm laparoscopic trocar for placement of Maryland bipolar forceps; Port 2: an 8-mm robotic trocar for placement of Cadiere forceps; Port 3: a 12-mm laparoscopic trocar as the assistant trocar; Port 4: an 8-mm robotic trocar for placement of an ultrasonic scalpel or electric cautery.

Initially, as described in previous studies **[9,16]**, a standard RPG with D1+ lymph node dissection was performed. In detail, lymph nodes in station No. 4sa, 4sb, 2, 7, 8, 9, 11, 10, 3 and 1 were sequentially retrieved according to the Japanese Gastric Cancer Treatment Guidelines **[3]**. The proximal stomach was then severed with 60-mm linear staplers at 4 cm above the tumor and 5 cm from the lower edge of the tumor, respectively. Notably, during this phase the right gastric artery and gastroepiploic artery were preserved, and the lower part of the esophagus was dissociated at approximately 5 cm. After this procedure, the specimen was placed in a sterile plastic bag.

Subsequently, the procedure proceeded to Kamikawa reconstruction. As shown in **Figure 3 and 4**, the creation of the double seromuscular flaps and hand-sewn esophagogastrostomy were performed entirely through a totally intracorporeally robotic approach. Firstly, the anterior wall of the remnant stomach near the greater curvature was labeled in a 3 × 3.5 cm "H" shape area with a solid blue line **(Figure 3B)**. Using a robotic cautery hook, the seromuscular and mucosal layers were cautiously detached, creating two seromuscular flaps **(Figure 3D)**.The submucosa and mucosa under the midline of the flaps were then opened, resulting in a gastric opening window with an upper and lower lip. Secondly, continuous full-thickness suturing using an absorbable unidirectional barbed suture was performed to fix the posterior wall of the esophagus, approximately 5 cm from the esophageal stump, to the anterior wall of the remnant

stomach **(Figure 4A)**. Third, the posterior wall of the esophageal stump was continuously sutured to the upper lip of the remnant gastric opening from left to right, involving the gastric mucosa, submucosa, and full-thickness esophagus, until the suture reached to the right apex **(Figure 4B)**. Notably, the suture needle was inserted through the mucosa and brought out through the serosal layer, and held for later use. Similarly, using a second barbed suture, the anterior wall of the esophageal stump was continuously sutured to the lower lip of the remnant gastric opening from right to left **(Figure 4C).** Fourth, the lower ends of the two flaps were fixed crosswise to the anterior wall of the stomach below the midpoint of the anastomosis. The two remaining interrupted sutures were used to continuously suture the lower edges of the two flaps to the anterior wall of the stomach from both sides to the middle, until they converged at the crossover point **(Figure 4D)**. Finally, two interrupted sutures were used along the midline to continuously suture the flaps to the esophageal adventitia for 3~4 stitches, and then sutured to both sides, eventually forming a "Y"-shaped collar-like structure **(Figure 4E)**.

Upon completion of Kamikawa anastomosis, an air leakage test was performed to confirm the closure of the anastomosis **(Figure 4F)**. A drainage tube was inserted via Port 2 and placed to the esophageal hiatus beneath the esophagogastrostomy. Postoperative gross specimen examination confirmed an invasive ulceration located at the gastric fundus and near the cardia **(Figure 1B)**.

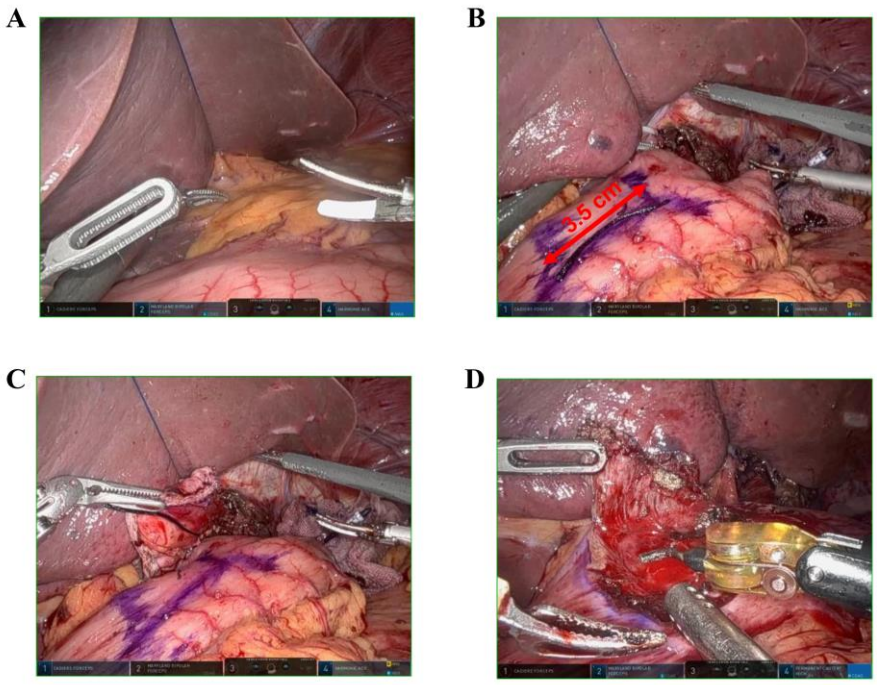

Figure 3: Creation of the double seromuscular flaps. A) Retract the left lateral lobe of the liver to fully expose the esophageal hiatus; B) Label a 3 × 3.5 cm "H" shape area with a solid blue line in the anterior wall of the remnant stomach near the greater curvature; C) Check a loose gastric stamp which can be easily reached to the distal esophagus; D) Use a robotic electric cautery to detach the seromuscular and mucosal layers.

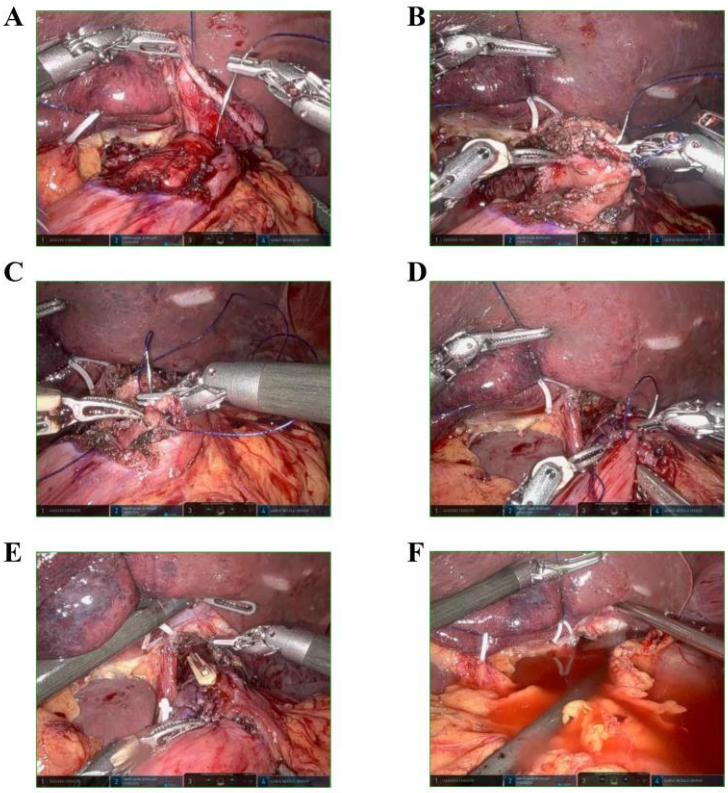

Figure 4: Process of Kamikawa reconstruction. A) Continuous full-thickness suturing to fix the posterior wall of the esophagus with the anterior wall of the remnant stomach; B) The posterior wall of the esophageal stump was continuously sutured to the upper lip of the remnant gastric opening from left to right; C) The anterior wall of the esophageal stump was continuously sutured to the lower lip of the remnant gastric opening from right to left; D) The two seromuscular flaps were fixed crosswise to the anterior wall of the stomach; E) A "Y"-shaped collar-like structure; F) An air leakage test was performed to confirm the closure of the anastomosis.

Perioperative outcomes

The whole operation took 220 minutes, involving an anastomosis time of 55 minutes. There was an estimated blood loss of 150 cc. The patient was discharged on postoperative day 8, during which the gastric tube was removed on the sixth postoperative day and then liquid diet started. The drainage tube was removed on the fifth postoperative day. No perioperative complications occurred. Postoperative gastrointestinal radiography at one month after surgery typically demonstrated unobstructed esophagogastrostomy, with no evidence of anastomotic fistulas or luminal narrowing **(Figure 5)**. Furthermore, the final pathology analysis reported gastric adenocarcinoma with 0/36 positive lymph nodes and a 3*2.8-cm ulcerative lesion. According to the 8th AJCC staging system, the final stage of this patient was pT3N0M0, pStage IIA.

Figure 5: Postoperative gastrointestinal radiography typically demonstrated unobstructed esophagogastrostomy.

Discussion

Nowadays, the pursuit of MIS that offers both oncological radicality and functional preservation has become a central focus of surgical management for gastric cancer. Laparoscopic and robotic platform are the two primary approaches employed in MIS, and laparoscopic or robotic gastrectomy is widely applied for patients with early upper-third gastric cancer or EGJ cancer **[17-20]**. Nevertheless, totally intracorporeal reconstruction during MIS remains one of the most technically difficult procedures and call for ongoing opportunities for improvement. Regarding Kamikawa reconstruction, most previous studies **[8,10,12,21-23]** have described surgeons performing this procedure through extracorporeal creation of seromuscular double flaps, followed by laparoscopic or open anastomosis. To the best of our knowledge, this study could be the first to report a case of RPG with totally intracorporeal Kamikawa reconstruction. We herein provided a comprehensive description of the surgical details and outcomes, aiming to contribute surgical experience and evidence supporting the feasibility and safety of the robotic approach in performing such surgery. Compared with laparoscopic surgery, robotics can facilitate complex maneuvers and enhance precision due to its advantages, such as tremor reduction, more flexible multi-articulated instruments, high-definition three-dimensional version and so on. Moreover, the usage of a robotic cautery hook allows for the creation of two flaps in a minimally invasive manner, which cannot be routinely performed through a laparoscopic approach. Collectively, these advantages make totally robotic Kamikawa anastomosis easier and more feasible. Given the high incidence of ≥ grade B reflux esophagitis (21.8~32.4%) after conventional esophagogastrostomy **[7,24]**, several anti-reflux techniques based on esophagogastrostomy have been proposed, including DFT, fundoplication, narrow gastric conduit, fixation of the esophagus into the diaphragm and lower esophageal sphincter preservation **[25-27]**. Among these techniques, DFT is highly recommended due to its efficacy in reducing reflux esophagitis (≥grade B) to as low as 0~6% **[5-8,10]**. Additionally, Kamikawa anastomosis provided several other benefits in surgical outcomes. It utilizes fewer staplers, resulting in reduced economic costs. It can also improve postoperative nutritional status

[6,9]. This anastomosis does not incorporate the small intestine, making small intestine-related complications rare in patients underwent such anastomosis. To facilitate the application of RPG with totally intracorporeal Kamikawa anastomosis, hereby we have outlined several key technical tips that may contribute to successful surgery: (1) retract the left lateral liver lobe to fully expose the esophageal hiatus, thereby expanding operating space for hand sewn anastomosis; (2) before anastomosis, it is essential to check a loose gastric stamp which can be easily reached to the distal esophagus. Avoid an excessively high esophageal transection; (3) use barbed sutures to reinforce the gastric stamp closure and the anastomosis, which may reduce bleeding and fistula formation while saving operating time;(4) to ensure enough blood supply for the anastomosis, preserve the right gastric artery and right gastroepiploic artery. The hepatic and pyloric branches of the vagus nerve, which can affect gastric peristalsis and gastric acid excretion, should also be preserved **[22]**; (5) to minimize anastomotic stenosis, the width of the mucosal opening window should match or be slightly larger than the width of the esophagus. Avoid using excessive stitches to further prevent stenosis.

In conclusion, RPG followed by totally intracorporeal Kamikawa anastomosis appears to be feasible and safe for patients with upper-third gastric cancer or EGJ cancer. Future research is warranted to validate the adequacy of performing such operation.

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Citation of this Article

Liang C, Guo J,Yuan Qi Y and Yuan S. Robotic Proximal Gastrectomy with Totally Intracorporeal Kamikawa Anastomosis: Technical Details and Short-Term Outcomes. Mega J Case Rep. 2025;8(1):2001-2010.

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