Gastric Carcinoma: Subtotal and Total Gastrectomy

Danson Yeo

Introduction

Gastric cancer is the fourth most common malignancy and the second most common cause of death among all malignancies worldwide [1]. More than half of new gastric cancer cases come from Eastern Asia (China and Japan), while Korea and Japan have the highest incidence rate in the world [2].

Risk factors for gastric cancer include tobacco smoking [3], alcohol consumption [4] and a high intake of salt and preserved foods [5]. *Helicobacter pylori* infection is an important risk factor for gastric cancer having been classified as a class I carcinogen [6], although only 1–3% of patients with *H. pylori* infection go on to develop gastric cancer [7].

The mainstay of curative treatment for gastric cancer is complete resection with lymphadenectomy.

Anatomy of the Stomach

The stomach has a rich anastomotic blood supply. The blood supply to the uppermost portion of the stomach and the lower esophagus is from a branch of the left inferior phrenic artery. The upper stomach is also supplied by the short gastric vessels in the gastrosplenic ligament, as well as small arteries arising from branches of the splenic artery towards the posterior wall of the fundus. If one of these vessels predominates, it is called the posterior gastric artery.

The largest blood supply comes from the left gastric artery arising from the celiac axis. The left gastric artery runs along the lesser curve of the stomach and joins with the right gastric artery. The right gastric artery is a branch of the common hepatic artery and supplies the region of the pylorus and lesser curve.

The blood supply along the greater curve comprises of the right gastroepiploic artery arising from the gastroduodenal artery, and the left gastroepiploic artery arising from the splenic artery.

Type of Surgery and Lymph Node Dissection

Surgical resection with lymphadenectomy is the gold standard of treatment for gastric cancer. Early cancers that meet the following criteria may be suitable for endoscopic resection; T1a lesion, differentiated-type adenocarcinoma without ulceration, diameter < 2 cm [8].

The standard surgery for either clinically node-positive (cN+) or > T2 tumors is either a total or distal gastrectomy. Distal gastrectomy may be performed when a satisfactory proximal resection margin can be obtained, otherwise total gastrectomy is performed. Tumors located along the greater curve with potential lymph node metastasis to station 4sb

D. Yeo (✉)
Upper Gastrointestinal and Bariatric Surgery, Department of General Surgery, Tan Tock Seng Hospital, Singapore, Singapore
e-mail: danson_xw_yeo@ttsh.com.sg

D. Lomanto et al. (eds.), *Mastering Endo-Laparoscopic and Thoracoscopic Surgery*,
https://doi.org/10.1007/978-981-19-3755-2_39

may require a total gastrectomy with splenectomy. For T1 tumors, a resection margin of 2 cm is recommended, for T2 tumors with expansive growth patterns, a proximal margin of at least 3 cm is recommended, while a proximal margin of at least 5 cm is recommended for tumors with an infiltrative growth pattern. If the above cannot be satisfied, frozen section examination of the proximal margin may be performed to ensure an R0 resection.

D2 lymphadenectomy is indicated for cN+ or > cT2 tumors while D1 or D1+ lymphadenectomy is sufficient for cT1N0 tumors. D2 lymphadenectomy should be performed whenever the possibility of nodal involvement cannot be excluded or the depth of tumor invasion is uncertain [8]. The Japanese Gastric Cancer Association defined the lymph nodes of the stomach and assigned station numbers [9]. Lymph node stations 1–12 and 14v are considered regional gastric lymph nodes, while metastasis to any other nodes is considered metastatic. The regional lymph node stations should be excised according to the type of gastric resection and the extent of lymphadenectomy as detailed in Table 1.

Contraindications

Gastrectomy as a reduction surgery for advanced gastric cancer with incurable factors such as unresectable liver metastasis and peritoneal metastasis is not recommended [8, 10]. Staging laparoscopy may be performed for patients at high risk of peritoneal dissemination, especially if neoadjuvant chemotherapy is being considered.

Surgical Technique

Instruments

- 3 × 12 mm ports, 2 × 5 mm ports
- Nathanson retractor (not required if alternative methods of liver retraction are used).
- 10 mm 30° laparoscope
- Advanced energy device—author preference is the Harmonic 1000I.
- Atraumatic graspers.
- Clip applicator.
- Suction/irrigation device.
- Laparoscopic stapler.

Operating Room Setup and Patient Position

The patient is placed in the supine position with both arms out and a footboard. The laparoscopic stack is placed on the patient's left, the machines for the energy devices are placed at the patient's feet, and the suction machine is placed on the patient's right.

The main surgeon stands on the patient's right along with the camera assistant, while the first assistant stands on the patient's left.

After the sub umbilical port is placed, the abdominal cavity is inspected for evidence of peritoneal metastasis. Pneumoperitoneum is maintained at 12 mmHg. Rest of the ports are placed as shown in Fig. 1. Retract the liver to expose the hiatus; author's preference is to use

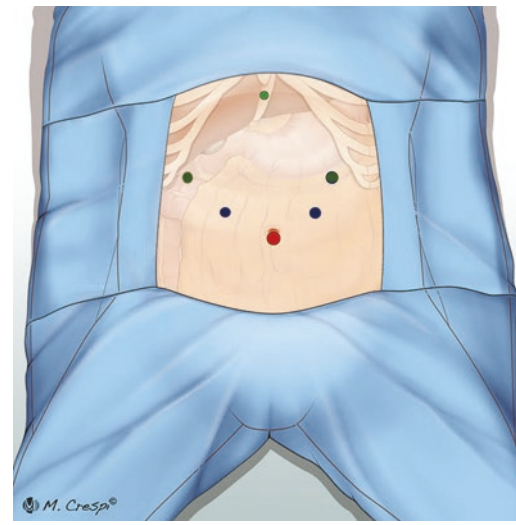


Fig. 1 Trocar placement

Table 1 Extent of lymphadenectomy according to the type of gastric resection

Gastrectomy	D1	D1+	D2
Subtotal gastrectomy	1, 3, 4sb, 4d, 5, 6, 7	(D1) + 8a, 9	(D1) + 8a, 9, 11p, 12a
Total gastrectomy	1, 2, 3, 4, 5, 6,7	(D1) + 8a, 9, 11p	(D1) + 8a, 9, 11p, 11d, 12a

the Nathanson liver retractor, others may use tape or sutures to sling the liver or a fan retractor.

Operative Steps: Distal Gastrectomy (Fig. 2)

Dissection of the Greater Omentum/ Left Gastrocolic Ligament (Station 4d)

- The surgeon's left hand and the assistant lifts the greater omentum/greater curve of the stomach.
- Incise the gastrocolic ligament at a transparent part of the omental bursa at least 3 cm away from the gastroepiploic arcade (Fig. 3).
- Continue the dissection towards the splenic flexure until the root of the left gastroepiploic artery/vein is reached (Fig. 4).
  - Be aware of the transverse colon and transverse mesocolon at all times.

Ligation of Left Gastroepiploic Vessels (Station 4sb)

- The surgeon's left hand grasps the left gastroepiploic vessels and lifts superiorly.

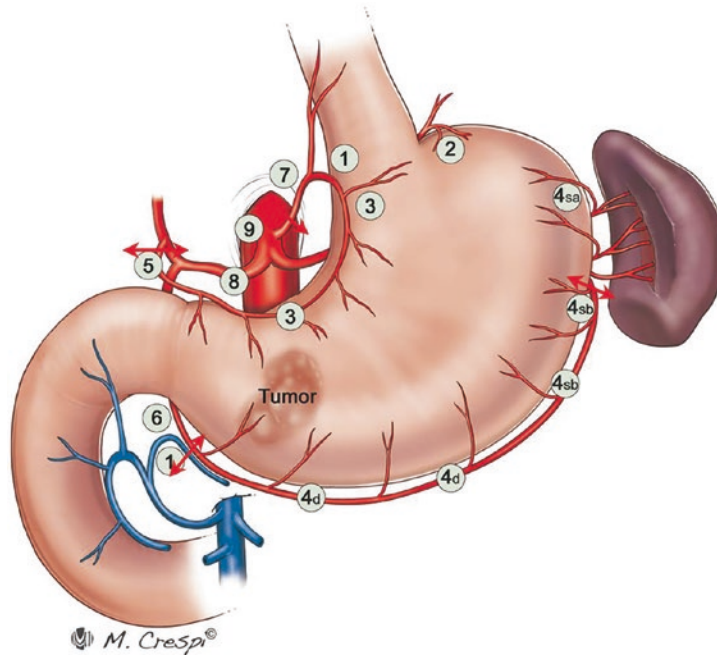


Fig. 2 Distal gastrectomy operative steps

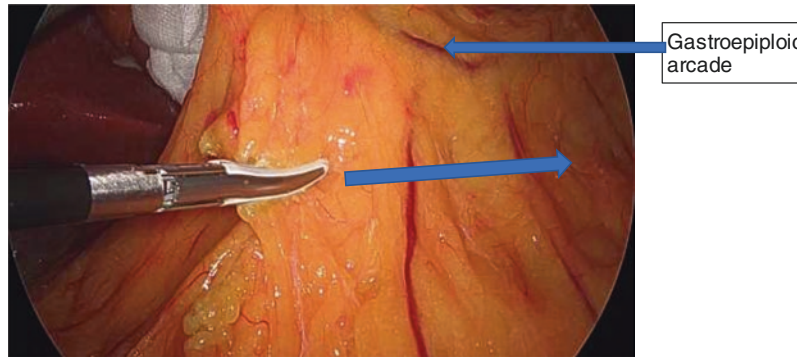


Fig. 3 Dissection of the greater omentum/left gastrocolic ligament

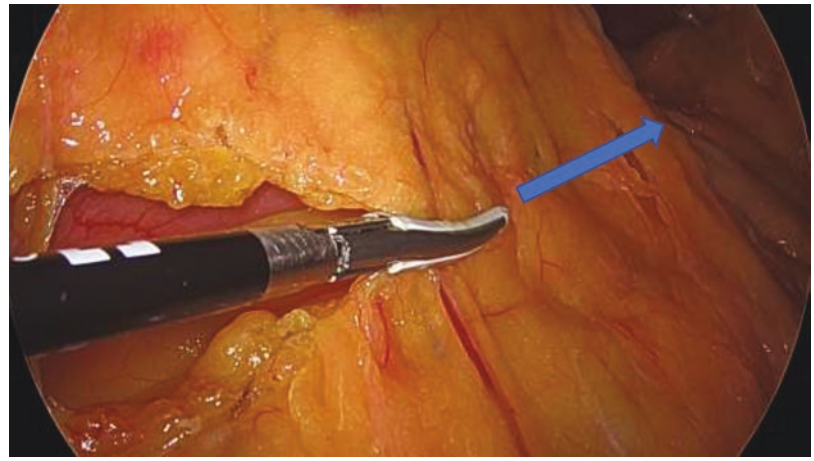


Fig. 4 Dissection of the greater omentum/left gastrocolic ligament

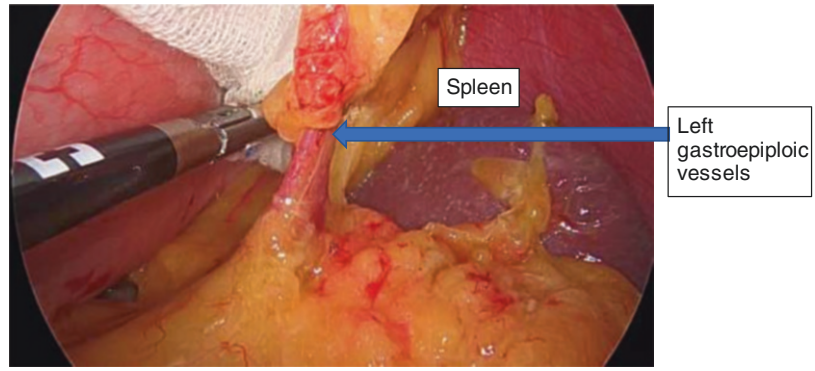


Fig. 5 Ligation of the left gastroepiploic vessels

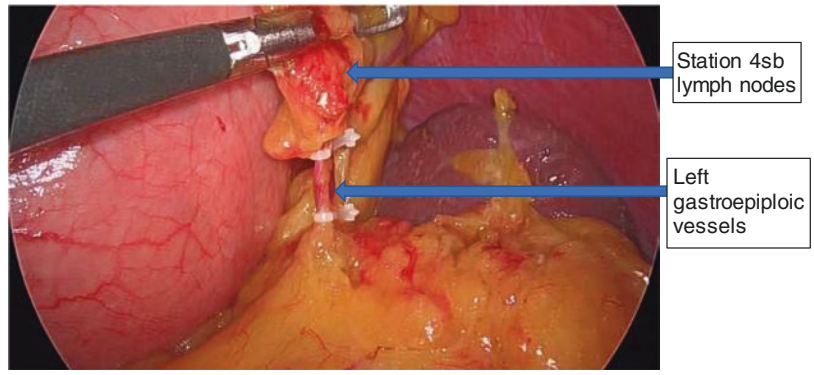


Fig. 6 Ligation of the left gastroepiploic vessels

- A gauze may be placed behind the stomach to aid in retraction and visualization of the vascular pedicle (Fig. 5).
- The left gastroepiploic artery may give off 2 branches; the omental and splenic branch. The left gastroepiploic vessels are divided distal to the omental and splenic branches between clips using the energy device (Fig. 6).
- The greater curvature vessels are divided close to the stomach until the avascular area is reached just before the short gastric vessels.

Dissection of the Greater Omentum/ Right Gastrocolic Ligament (Station 4d)

- The surgeon's left hand holds up the gastroepiploic arcade, while the assistant lifts up the stomach.
- The dissection is continued along the gastrocolic ligament towards the right gastroepiploic vessels and head of pancreas (Fig. 7).
- Adhesions between the gastrocolic ligament and the transverse mesocolon are best divided with blunt dissection to avoid injury to the middle colic vessels within the transverse mesocolon.
- Take down any adhesions between the posterior stomach and pancreas/transverse mesocolon until the gastroduodenal artery is exposed (Fig. 8).
  - Be aware of the middle colic vessels that may be adherent to the gastrocolic ligament.

Ligation of the Right Gastroepiploic Artery (Station 6)

- Surgeon's left hand holds up the right gastroepiploic vessels while the assistant lifts up the posterior stomach and provides countertraction (Fig. 9).
- The right gastroepiploic vein is clipped while preserving the anterior superior pancreaticoduodenal vein (Fig. 10), while the right gastroepiploic artery is clipped at the junction of the gastroduodenal artery (Fig. 11).
- The omentum is dissected off the duodenum/pylorus (Fig. 12).
  - Be careful to avoid injury to the pancreas.

Dissection of the Hepatoduodenal Ligament

- Place a gauze below duodenum and the hepatoduodenal ligament.

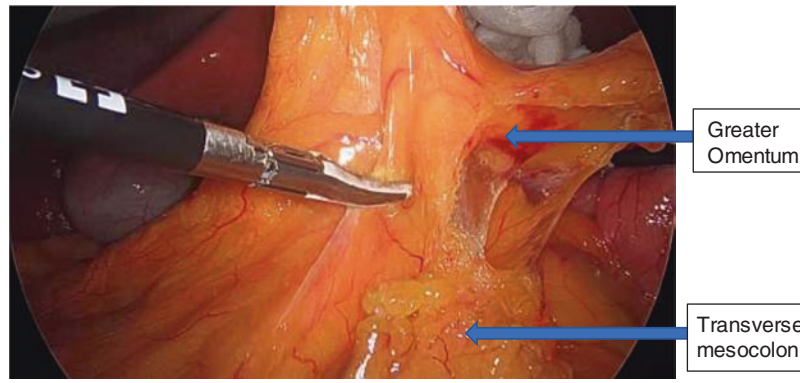


Fig. 7 Dissection of the greater omentum/right gastrocolic ligament

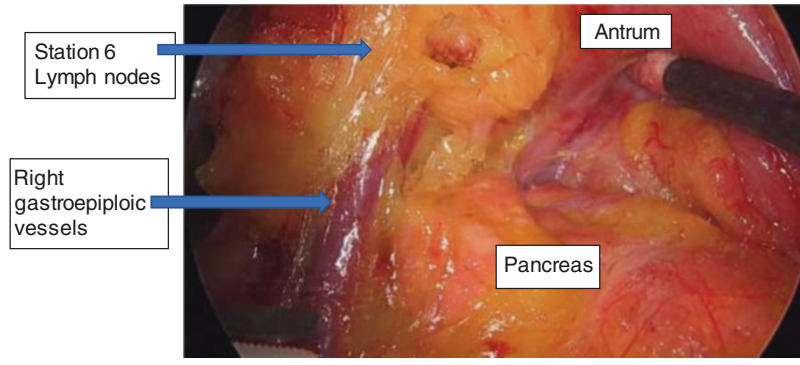


Fig. 8 Dissection of the greater omentum/right gastrocolic ligament

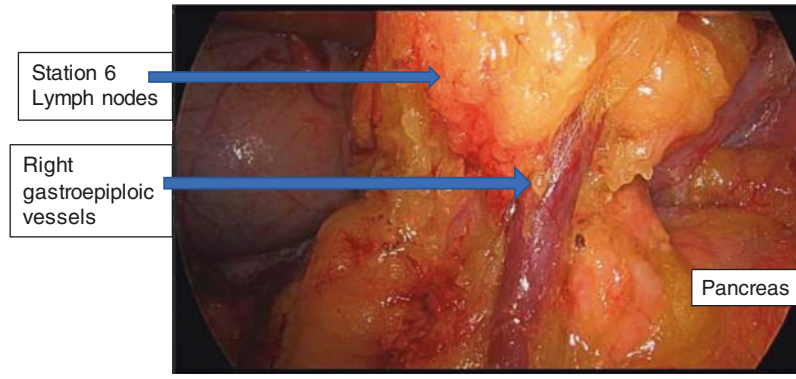


Fig. 9 Right gastroepiploic vessels

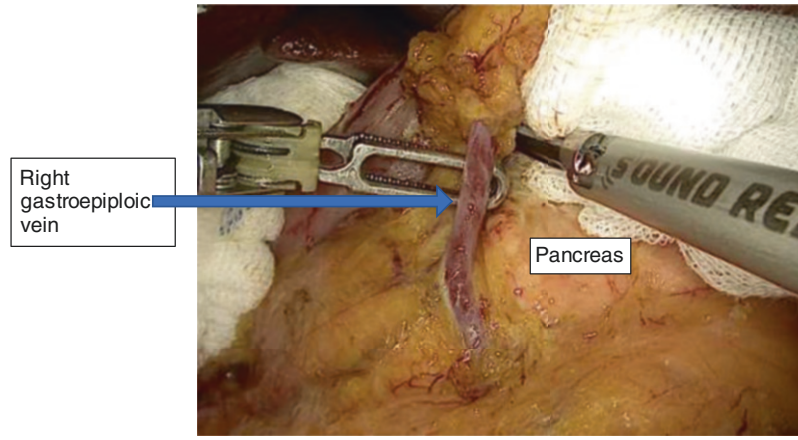


Fig. 10 Right gastroepiploic vein

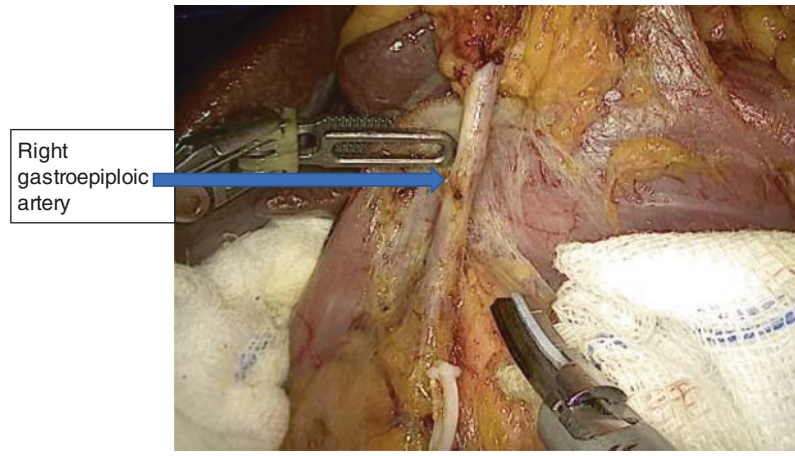


Fig. 11 Right gastroepiploic artery

- Incise the hepatoduodenal ligament (Fig. 13).
- Surgeon's left hand holds up the right gastric vessels while the assistant retracts the pylorus inferiorly.
- Dissect the right gastric vessels off the pylorus with an energy device, small feeding vessels may be encountered during this dissection. Hemostasis can be achieved with the energy device.

  – The gauze placed posterior protects the pancreas and the common hepatic artery from injury.

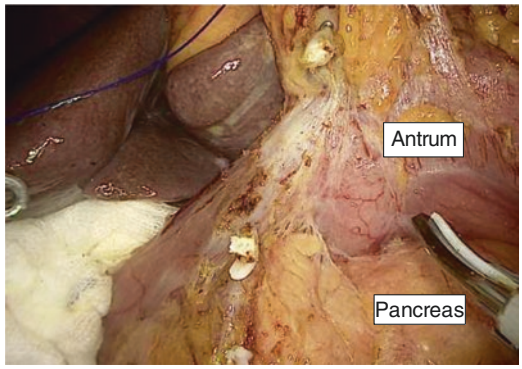


Fig. 12 Post ligation of the right gastroepiploic vessels

Ligation of the Right Gastric Artery and Dissection Along the Hepatic Artery Proper (Station 5)

- Hold up the right gastric vessels superiorly, exposing its origins from the hepatic artery proper. The lymph nodes at the root of the right gastric vessels are dissected (station 5 lymph nodes) (Fig. 14).
- The right gastric vessels are divided between clips at the root (Fig. 15).

Transection of the Duodenum

- The duodenum is transected with a stapler (Fig. 16).

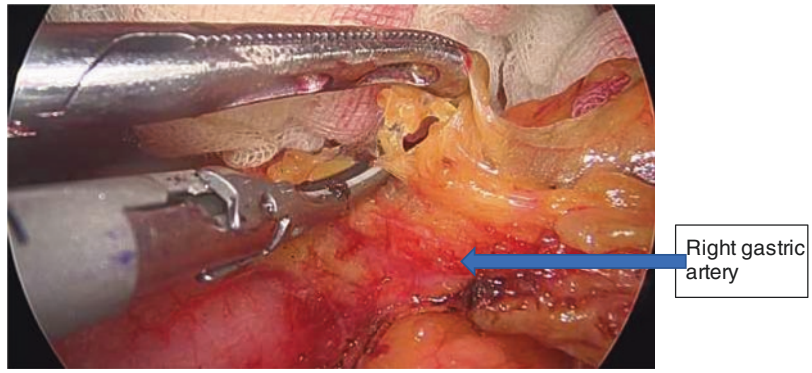


Fig. 13 Dissection of the hepatoduodenal ligament

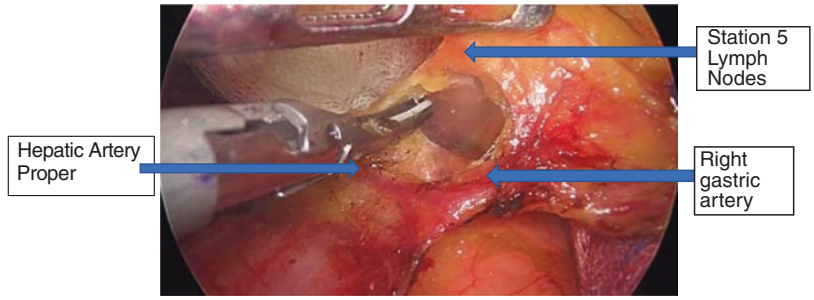


Fig. 14 Exposing the right gastric artery at the root

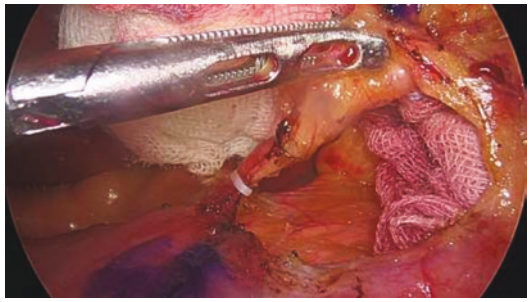


Fig. 15 Ligation of the right gastric vessels

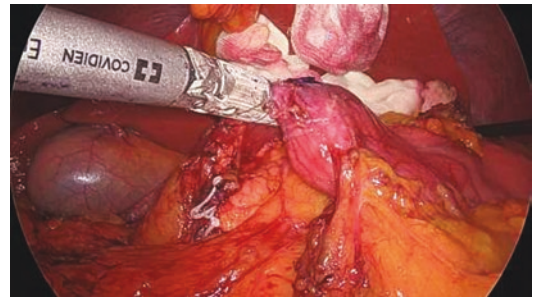


Fig. 16 Transection of the duodenum

  - Ensure that the vascular clips are not caught in the stapler jaws prior to firing the stapler.
- After transection, the stomach is flipped away to the left to expose the celiac axis (Fig. 17).

Opening of the Hepatogastric Ligament/Lesser Omentum

- The lesser omentum is opened up until the right crus (Fig. 18).

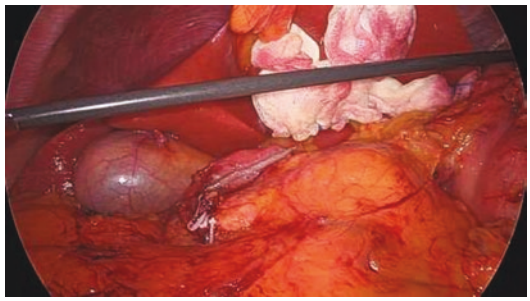


Fig. 17 Expose the celiac axis

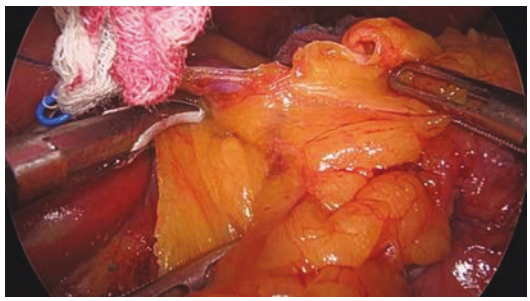


Fig. 18 Opening of the hepatogastric ligament/lesser omentum

  - Beware of a replaced left hepatic artery arising from the left gastric artery that may be traversing the lesser omentum.

Dissection Along the Common Hepatic Artery and Splenic Artery (Station 8a, 12a and 11)

- The assistant holds up the left gastric vessels superiorly while gently retracting the pancreas inferiorly. Surgeon's left hand holds up the fatty tissue over the superior border of the pancreas (Station 8a lymph node) and dissects it off the common hepatic artery. The dissection may be continued posteriorly along the hepatic artery to expose the portal vein, thereby taking Station 12a lymph nodes as well.
- The dissection is continued along the upper border of the pancreas from the common hepatic artery (Fig. 19), across the celiac axis onto the splenic artery to excise Station 11p lymph nodes along the splenic artery (Fig. 20).

Ligation of the Left Gastric Artery (Station 7, 9)

- The assistant lifts the left gastric vessels and pulls the pancreas downwards to expose the celiac axis.
- Dissect out the coronary vein (Fig. 21) and the left gastric artery (Fig. 22), dividing the vessels between clips (Fig. 23) (The coronary vein usually lies anterior to the left gastric artery).

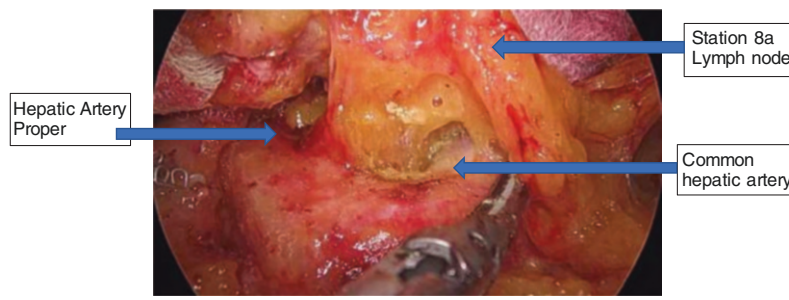


Fig. 19 Dissection along the common hepatic artery and splenic artery

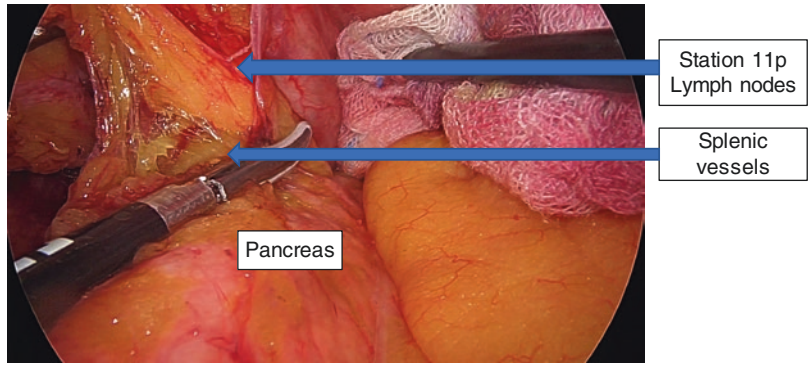


Fig. 20 Dissection of Station 11p Lymph Nodes

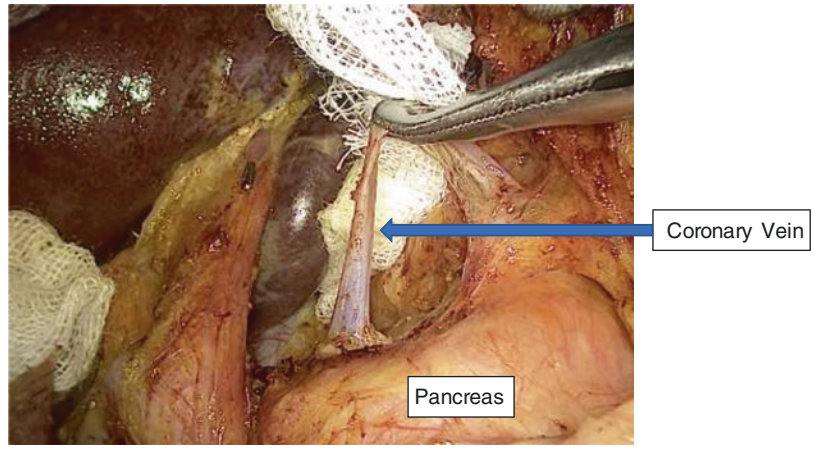


Fig. 21 Coronary vein

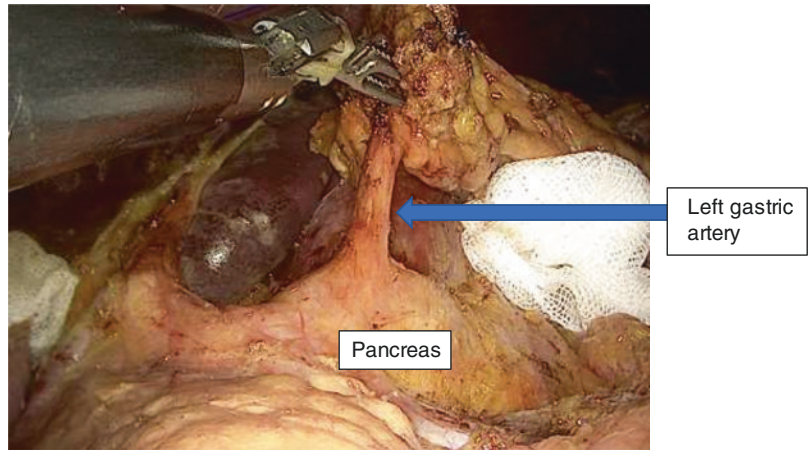


Fig. 22 Left gastric artery

Dissection of the Proximal Lesser Curve (Station 1)

- The lesser omentum is divided until the esophagus is reached (Fig. 24).
- The surgeon's left hand and the assistant holds up Station 1 lymph nodes to provide traction.
- Station 1 lymph nodes are excised off the right crus, the cardio-esophageal junction, and thereafter the lesser curve of the stomach (Fig. 25).

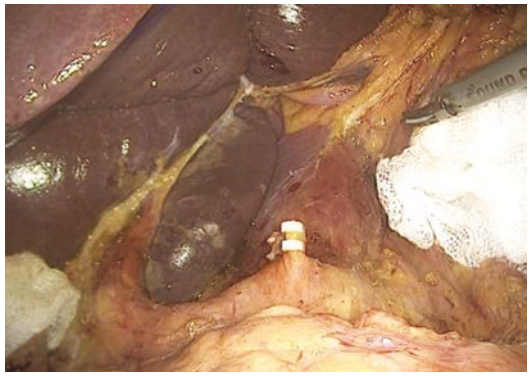


Fig. 23 Ligation of left gastric vessels

- The anterior vagus nerve is transected during this step.
  - Avoid injury to the distal esophagus during dissection.

Transection of the Proximal Stomach

- Transection of the proximal stomach is performed with a stapler (Fig. 26).
  - Ensure that any nasogastric tube in the stomach is removed prior to stapling.
  - In cases where there is a concern of cancer invasion of the proximal staple line, remove the specimen first for inspection with consideration of frozen section examination of the proximal staple line.

Figure 27 shows the vessels of the celiac axis stripped of lymph nodes, and proximal transection of the stomach completed.

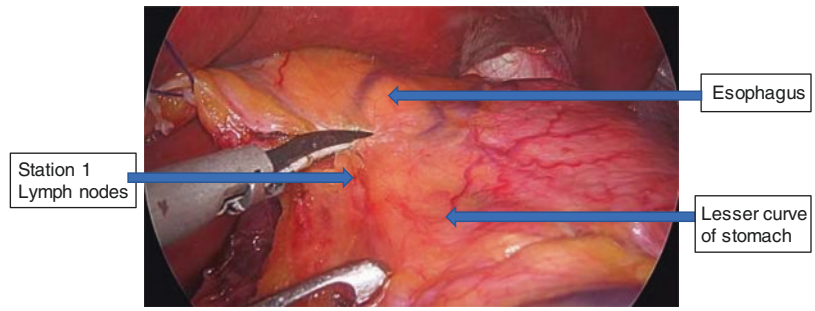


Fig. 24 Dissection of the proximal lesser curve

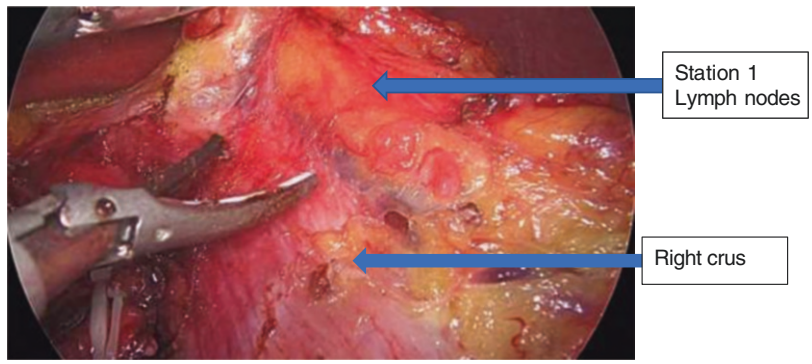


Fig. 25 Dissection of Station 1 Lymph nodes

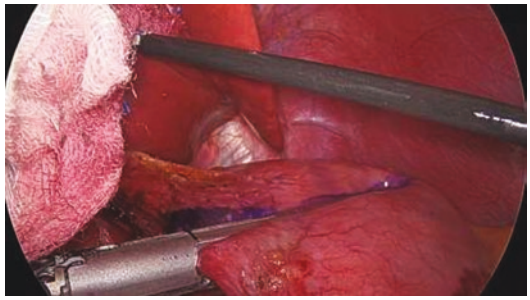


Fig. 26 Transection of the proximal stomach

Anastomosis

- Possible anastomosis includes a Billroth II anastomosis, Roux-En-Y anastomosis (Figs. 28 and 29), or Delta anastomosis.
- Type of anastomosis performed depends on the surgeon's experience and patient factors.

Fig. 27 Post dissection of lymph nodes around the celiac axis

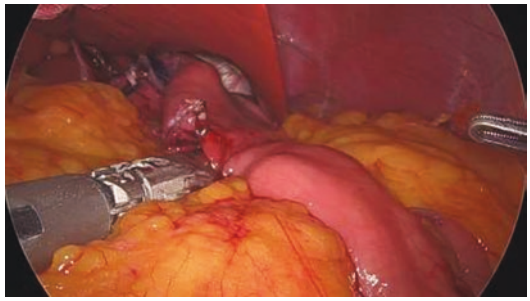


Fig. 28 Stapled Roux-En-Y gastrojejunal anastamosis

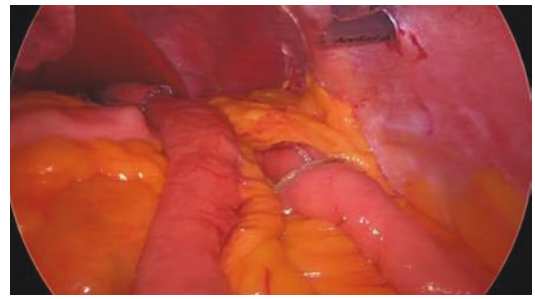


Fig. 29 Stapled Jejunal-jejunal anastamosis

Operative Steps: Total Gastrectomy

Additional Steps

- After ligation of the left gastroepiploic vessels (Step 2 of distal gastrectomy), the dissection is continued cephalad dividing the short gastric vessels until the left crus is reached.
- Lymph node station 4sa is taken along with the short gastric vessels (Fig. 30).
- Lymph node station 2 dissected off the angle of His to expose the cardioesophageal junction on the left (Fig. 31).
- Station 1 lymph nodes are dissected off the esophagus until the level of the cardioesophageal junction (Fig. 32).
- A short distance of the thoracic esophagus may be dissected through the hiatus in order to reduce tension in the subsequent anastomosis (Fig. 33).

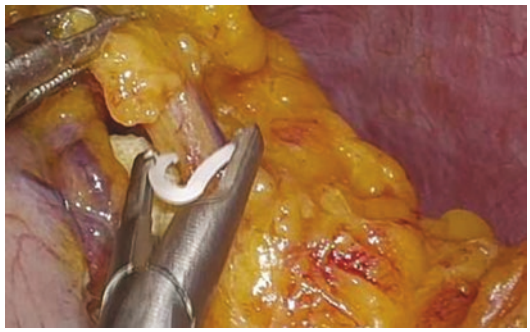
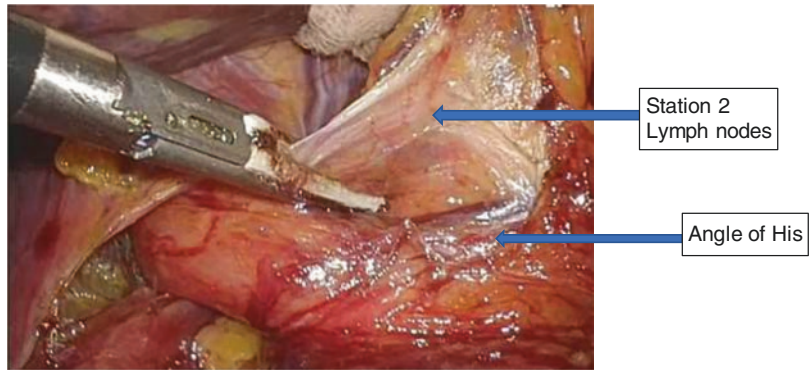


Fig. 30 Short gastric vessels

Anastomosis

- Perform a Roux-en-Y esophageal-jejunal anastomosis.
- Anastomosis can be a side-to-side linear stapled anastomosis (Fig. 34), an end-to-side circular stapled anastomosis with an orvil (Fig. 35), or a handsewn anastomosis.

Fig. 31 Dissection of Station 2 lymph nodes



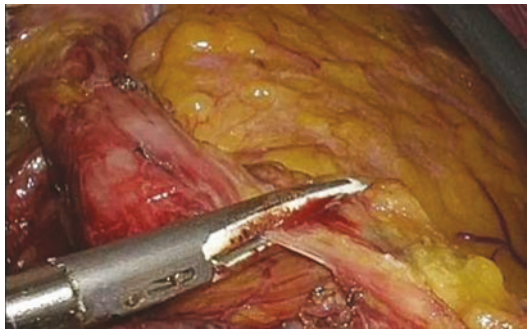


Fig. 32 Dissection of station 1 lymph nodes

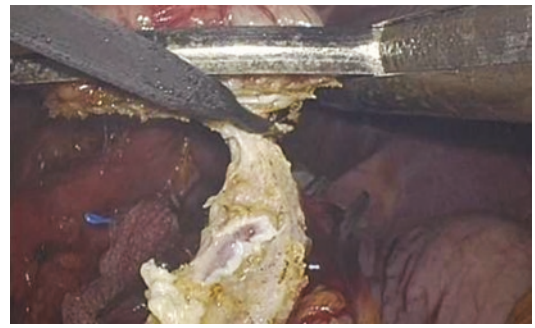


Fig. 33 Transection of the esophagus

Fig. 34 Linear Stapled side-side anastamosis

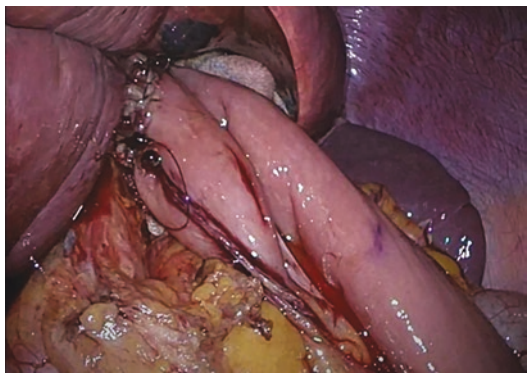


Fig. 35 End-side Circular anastomosis

Complications

Patients who are septic post-gastrectomy should undergo a Computed Tomographic scan of the abdomen and pelvis with intravenous and oral contrast. Potential sources of sepsis include pneumonia, intra-abdominal collections, leak from the anastomosis, or duodenal stump.

Long-term complications after total gastrectomy include dumping syndrome and Vitamin B12 deficiency. Patients with vitamin B12 deficiency may require regular intramuscular vitamin B12 injections.

References

1. Sitarz R, Skierucha M, Mielko J, Offerhaus GJA, Maciejewski R, Polkowski WP. Gastric cancer: epidemiology, prevention, classification, and treatment. Cancer Manag Res. 2018;10:239–48.
2. Inoue M, Tsugane S. Epidemiology of gastric cancer in Japan. Postgrad Med J. 2005;81(957):419–24.
3. Humans IWGotEoCRt and IARC Working Group. Tobacco smoke and involuntary smoking. IARC Monogr Eval Carcinog Risks Hum. 2004;83:1–1438.
4. Glade MJ. Food, nutrition, and the prevention of cancer: a global perspective. American Institute for Cancer Research/World Cancer Research Fund, American Institute for Cancer Research, 1997. Nutrition. 1999;15(6):523–6.
5. WHO, Joint, and FAO Expert Consultation. Diet, nutrition and the prevention of chronic diseases. World Health Organ Tech Rep Ser 2003;916(i-viii), 1–149, backcover.
6. International Agency for Research on Cancer. Schistosomes, liver flukes and Helicobacter pylori. IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. Lyon, 7–14 June 1994. IARC Monogr Eval Carcinog Risks Hum. 1994;61:1–241.
7. Suerbaum S, Michetti P. Helicobacter pylori infection. N Engl J Med. 2002;347(15):1175–86.
8. Japanese Gastric Cancer Association. Japanese gastric cancer treatment guidelines 2018 (5th edition). Gastric Cancer. 2020.
9. Japanese Gastric Cancer A. Japanese classification of gastric carcinoma: 3rd English edition. Gastric Cancer. 2011;14(2):101–12.
10. Fujitani K, Yang HK, Mizusawa J, et al. Gastrectomy plus chemotherapy versus chemotherapy alone for advanced gastric cancer with a single non-curable factor (REGATTA): a phase 3, randomised controlled trial. Lancet Oncol. 2016;17(3):309–18.