4 Robotic Segmental Gastrectomy for Large Gastrointestinal Stromal Tumor

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Introduction

Gastrointestinal stromal tumors (GISTs) are the most common soft tissue tumors of the gastrointestinal tract. They originate from mesenchymal cells believed to be precursors of the interstitial cells of Cajal [1, 2]. While the estimated annual age-adjusted incidence of GISTs in the US was 0.78/100,000 in 2011 [3], the true incidence may be underreported [4]. Most of these GISTs occur within the stomach [5, 6] and although the exact locations within the stomach are variable, the majority of cases are detected in the antrum [7]. GISTs are predominantly initiated by gain-of-function mutations in *KIT* (c-KIT) [8], which is the target for the tyrosine kinase inhibitor imatinib that extends recurrence free survival and overall survival in the adjuvant setting [9, 10]. Resectable GISTs necessitate removal of the tumor with negative surgical margins [5], but there is no requirement for regional lymphadenectomy, given the low incidence of lymph node metastases [11].

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Minimally Invasive Techniques for Resection of GIST

Open gastrectomy has been traditionally considered the gold standard operative approach for GISTs. However, the introduction of minimally invasive surgical techniques has shifted the trend towards utilizing laparoscopic and robotic surgical approaches with the benefits of decreased postoperative pain, shorter hospital length of stay, and quicker recuperation.

Multiple studies have evaluated the role of minimally invasive techniques for resection of gastric GIST. Laparoscopic surgery has been shown to be safe and effective for the surgical management of GISTs, including large tumors and tumors located in technically challenging locations (e.g., gastroesophageal junction, lesser curvature, and posterior wall of the stomach [12–16]. There are few studies that have examined robotic surgery for the resection of GIST. Small case series have reported the feasibility of robot-assisted techniques to remove gastric and duodenal GISTs [17–19]. The

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enhanced maneuverability, improved visualization, and ergonomic ease afforded by the robotic platform compared to conventional laparoscopic surgery may allow the surgeon to perform resections in more challenging locations [18]. In this chapter, we outline the step-by-step surgical procedure in performing robotic segmental resection of a large GIST located near the junction of the cardia, fundus, and body.

Anatomy of the Stomach

The stomach has a rich vascular network of arteries and veins. The major arterial inflow originates from the branches of the celiac trunk, which gives off three branches including the left gastric artery, splenic artery and the common hepatic artery. The left gastric artery supplies primarily the lesser curvature of the stomach and the gastroesophageal junction. The splenic artery courses behind the superior border of the pancreas, and its branches include the short gastric vessels and the left gastroepiploic artery, which supplies the greater curvature of the stomach. Finally, the major branches of the common hepatic artery include the right gastric artery that supplies the lesser curvature and the pylorus and the gastroduodenal artery that joins the right gastroepiploic artery to supply the greater curvature of the stomach. Venous drainage follows that of the arterial network, emptying into the portal venous system via the splenic and superior mesenteric veins. The coronary vein (*aka* left gastric vein) runs adjacent to the left gastric artery and drains directly into the portal vein. The stomach has an extensive lymphatic drainage system; however, GISTs have very low risk of lymph node metastases, and regional lymphadenectomy is not required for these cancers [11].

Case Evaluation

The patient is a 40-year-old male with an 8-cm tumor originating from the submucosal layer of the anterior wall of the stomach near the borders of the cardia, fundus, and body of the stomach. The patient initially presented to the emergency department with hematemesis. Upper endoscopy was performed and identified a large bleeding tumor that appeared consistent with GIST. Endoscopic biopsies were performed and confirmed the diagnosis. Computed tomography (CT) imaging of the abdomen and pelvis demonstrated an 8-cm-wide based tumor in the proximal stomach with no evidence of distant metastatic disease (Fig. 4.1a, b). We considered the option of a neoadjuvant approach [20, 21]; however, given the bleeding and need for blood transfusions, we elected to proceed to the operating room.

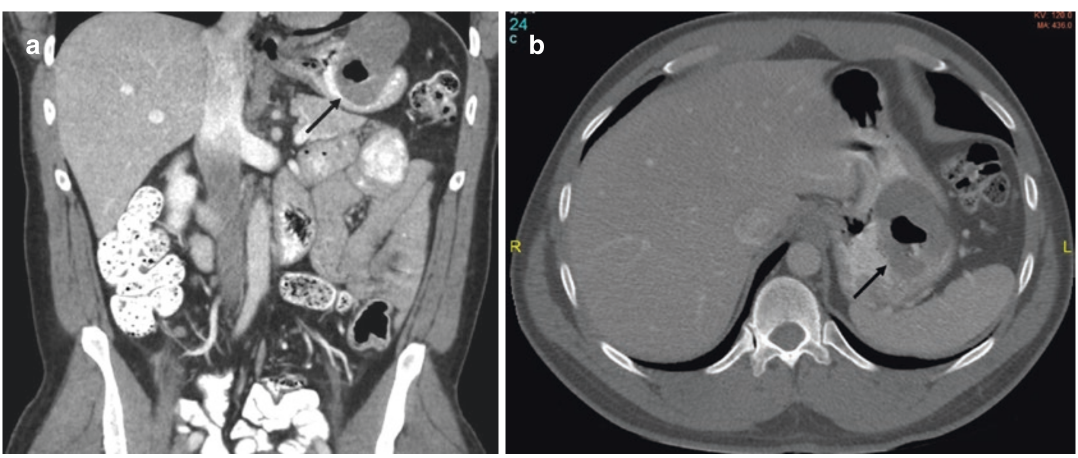

Fig. 4.1 (**a**) Coronal reconstruction of computed tomography scan demonstrating large proximal gastric cancer (black arrow). (**b**) Axial reconstruction of the same proximal gastric cancer (black arrow)

Pre-operative Considerations

After diagnosis of GIST has been confirmed, several steps are necessary prior to surgical intervention. This includes a staging workup consisting of endoscopic ultrasound (EUS) and CT scans of the chest, abdomen, and pelvis to evaluate the extent of disease and to rule out distant metastasis. Patients with unresectable or borderline resectable disease or GISTs in technically challenging locations (e.g., gastroesophageal junction) may benefit from neoadjuvant therapy with imatinib to downsize the tumor and increase the likelihood of complete surgical resection [20, 21]. Other tests may be required based on patient age and presence of comorbidities. No preoperative bowel prep is administered.

Surgical Technique

Patient Positioning and Setup

After transport to the operating room, the patient is placed in the supine position on the operating room table. We do not use the lithotomy position or split legs for gastrectomy. Prior to induction of general endotracheal anesthesia, sequential compression devices are placed on the bilateral lower extremities, and intravenous antibiotics are administered. After endotracheal intubation, a Foley catheter and orogastric tube are placed. We do not place central venous catheters, although radial artery catheters are often placed to facilitate accurate hemodynamic monitoring. Once these initial steps have been completed, both arms are tucked and the abdomen is prepped and covered with an Ioban drape.

Instruments

For this procedure, we used the following robotic instruments: fenestrated bipolar forceps, robotic hook with monopolar cautery, prograsp forceps, cadiere forceps, and needle driver. We used the following laparoscopic instruments: scissors, LAPRA-TY clip applier (Ethicon Endo Surgery), suction/irrigation, endo-GIA linear stapler, and thermal energy device.

Port Placement and Docking the Robot

For gastric resection, we favor placing five ports that are one hand-breadth apart in a semicircular line with the camera port at the umbilicus (Fig. 4.2). Initial entry at the umbilicus is established using a modified Hassan technique with placement of a 10/12-mm balloon port. Under direct visualization, an 8-mm robotic port for robotic arm 1 is placed in the left lateral abdomen in the mid-axillary line. We place a 10/12-mm assistant port in the right mid-abdomen in the mid-clavicular line. Robotic arms 2 and 3 are placed in mirror positions on the right and left sides of the abdomen. Once the trocars are placed, the Da Vinci robotic platform (Intuitive) is brought in over the left side of the patient's head (Si) or on the patient's left side (Xi). The Si platform was used for this procedure (Fig. 4.3).

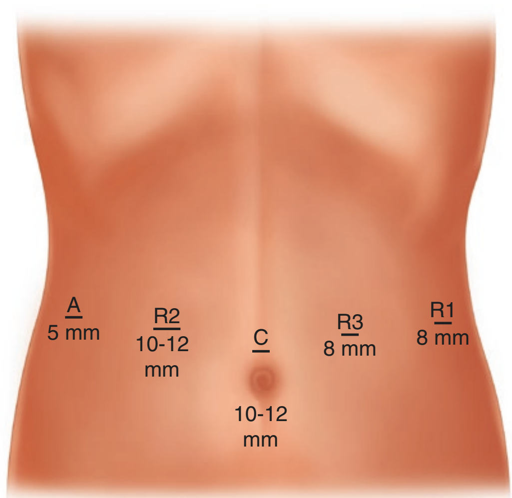

Fig. 4.2 Trocar placement for robotic wedge gastrectomy. Robotic arm #3 may be unnecessary under select conditions

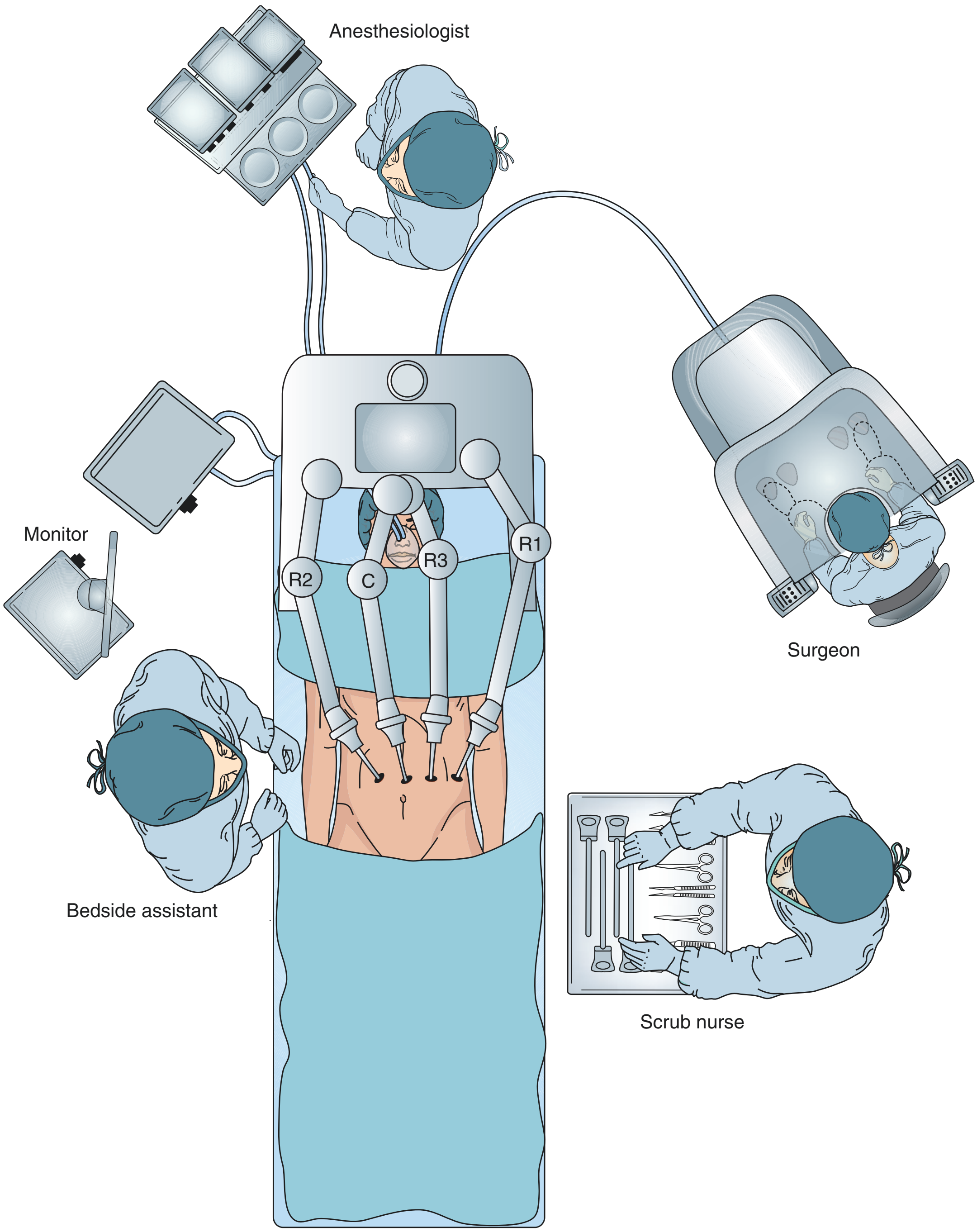

Fig. 4.3 Robotic setup for wedge gastrectomy using the Da Vinci Si platform

Surgical Steps (Video 4.1)

Upon entry into the abdominal cavity, an exploration was performed to assess for distant metastatic disease and none was identified. The approximately 8-cm tumor was visualized on the anterior aspect of the proximal stomach near the cardia (Fig. 4.4a, b). We considered surgical options including proximal gastrectomy and wedge resection. Given the size and location of the tumor, we were concerned about potentially narrowing the gastroesophageal junction with partial gastrectomy. However, proximal gastrectomy has considerable surgical risks including anastomotic leak and bile reflux. We elected to perform circumferential wedge resection of the tumor to minimize the amount of resected tissue, while obtaining negative surgical margins.

Although we did not utilize a dedicated liver retractor, other surgeons could employ one of several different options (e.g., Nathanson liver retractor). We used a prograsp in robotic arm 3 to retract the liver when needed. To minimize the amount of tissue necessary for resection of the GIST, the anterior aspect of the stomach was opened using monopolar cautery with the hook in robotic arm 1. Alternatively, the stomach could have been opened with the Ligasure (Covidien) through the assistant port. Opening the stomach is an oncologically acceptable step for GISTs, which are submucosal tumors, but it is not appropriate for gastric adenocarcinoma.

Fenestrated bipolar grasper in robotic arm 2 was used to retract the stomach, while an endoscopic GIA linear stapling device was placed through the assistant port. Serial firings of the stapler with 60-mm tan cartridges were used to circumferentially resect the tumor, ensuring grossly negative margins. We elected not to use the robotic stapler because of the lack of vascular cartridges and the need for a 15-mm trocar. Alternatively, cautery or a thermal sealing device can be employed to perform this resection. Once the tumor was completely resected, the tumor was placed in a specimen bag which was placed through the assistant port.

We closed the gastrotomy defect along a longitudinal plane rather than a transverse plan to avoid having the stomach fold over on itself. To avoid potentially narrowing the gastroesophageal junction with linear stapling devices, the closure was performed with robotic suturing in two layers with 3-0 PDS running suture. First, the two sides of the proposed incision line were loosely approximated with sutures that were secured with LAPRA-TY clips (Ethicon Endo Surgery). A running suture was then started with the needle driver in robotic arm 1 in a cranial to caudal direction. We placed a LAPRA-TY clip at both ends of the suture line instead of tying knots. A second 3-0 PDS running suture was placed as the second, outer layer. A final inspection for hemostasis was performed and the robot was undocked. The specimen bag is exteriorized by enlarging

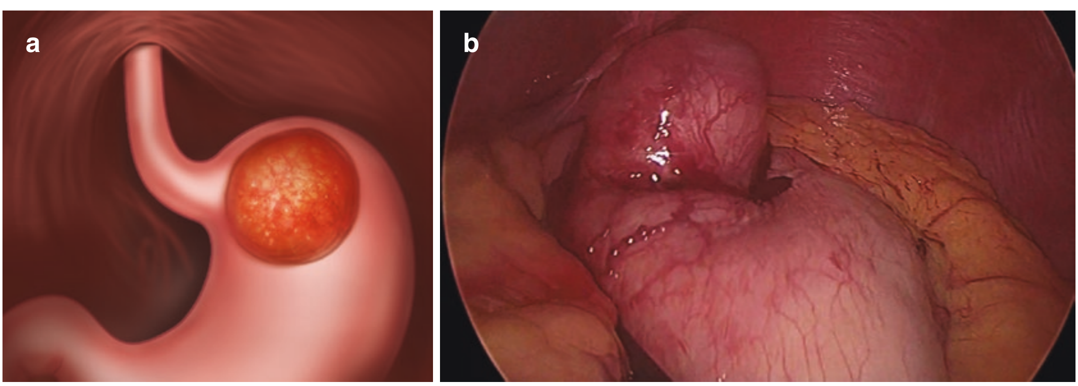

Fig. 4.4 (**a**) Illustration showing the location of the large, proximal gastric tumor on the anterior surface of the stomach. (**b**) Paired intraoperative image revealing only a small portion of the large gastric tumor

the assistant port. The fascial incisions of the 10/12-mm port sites were closed with the Carter-Thomason device using 0 Vicryl sutures and the skin was closed with subcuticular absorbable sutures. We did not leave an intraperitoneal drainage catheter.

Postoperative Care and Complications

Postoperative management after robotic wedge gastrectomy is the same as that after open surgery. Patients are generally managed on the regular surgical floors without need for intensive care units. It is our current routine to use nasogastric tubes (NGTs), which are removed on postoperative day #2. As we transition to enhanced recovery after surgery protocols, we will no longer use NGTs in the postoperative period. Furthermore, we do not perform upper gastrointestinal radiographic studies prior to removal of NGTs. After the NGT has been removed, a liquid diet is started and advanced as tolerated. Postoperative pain is controlled by non-narcotic analgesia which is supplemented as needed with patient-controlled analgesia and oral narcotic regimens. Patients are typically discharged home on postoperative day #4. Although patients may be at risk for the same postoperative complications observed with open gastric resection, we have never had anastomotic leak with wedge resection, and our rates of morbidity are quite low with zero mortality over the past decade.

Conclusions

Robotic wedge gastrectomy is feasible and safe for gastric GISTs in challenging locations. The greatest advantage with the robotic platform for our procedure was the ease in closing the resection defect with long running sutures. Straightforward robotic suturing can be performed safely by both experienced gastric surgeons and trainees alike.

References

1. Kindblom LG, Remotti HE, Aldenborg F, et al. Gastrointestinal pacemaker cell tumor (GIPACT): gastrointestinal stromal tumors show phenotypic characteristics of the interstitial cells of Cajal. Am J Pathol. 1998;152(5):1259–69.
2. Miettinen M, Sarlomo-Rikala M, Lasota J. Gastrointestinal stromal tumors: recent advances in understanding of their biology. Hum Pathol. 1999;30(10):1213–20.
3. Ma GL, Murphy JD, Martinez ME, et al. Epidemiology of gastrointestinal stromal tumors in the era of histology codes: results of a population-based study. Cancer Epidemiol Biomarkers Prev. 2015;24(1):298–302.
4. Choi AH, Hamner JB, Merchant SJ, et al. Underreporting of gastrointestinal stromal tumors: is the true incidence being captured? J Gastrointest Surg. 2015;19(9):1699–703.
5. DeMatteo RP, Lewis JJ, Leung D, et al. Two hundred gastrointestinal stromal tumors: recurrence patterns and prognostic factors for survival. Ann Surg. 2000;231(1):51–8.
6. Miettinen M, Lasota J. Gastrointestinal stromal tumors: pathology and prognosis at different sites. Semin Diagn Pathol. 2006;23(2):70–83.
7. Miettinen M, Sobin LH, Lasota J. Gastrointestinal stromal tumors of the stomach: a clinicopathologic, immunohistochemical, and molecular genetic study of 1765 cases with long-term follow-up. Am J Surg Pathol. 2005;29(1):52–68.
8. Hirota S, Isozaki K, Moriyama Y, et al. Gain-of-function mutations of c-kit in human gastrointestinal stromal tumors. Science. 1998;279(5350):577–80.
9. Dematteo RP, Ballman KV, Antonescu CR, et al. Adjuvant imatinib mesylate after resection of localised, primary gastrointestinal stromal tumour: a randomised, double-blind, placebo-controlled trial. Lancet. 2009;373(9669):1097–104.
10. Joensuu H, Eriksson M, Sundby Hall K, et al. One vs three years of adjuvant imatinib for operable gastrointestinal stromal tumor: a randomized trial. JAMA. 2012;307(12):1265–72.
11. Tokunaga M, Ohyama S, Hiki N, et al. Incidence and prognostic value of lymph node metastasis on c-Kit-positive gastrointestinal stromal tumors of the stomach. Hepato-Gastroenterology. 2011;58(109):1224–8.
12. De Vogelaere K, Hoorens A, Haentjens P, et al. Laparoscopic versus open resection of gastrointestinal stromal tumors of the stomach. Surg Endosc. 2013;27(5):1546–54.
13. MacArthur KM, Baumann BC, Nicholl MB. Laparoscopic versus open resection for gastrointestinal stromal tumors (GISTs). J Gastrointest Cancer. 2017;48(1):20–4.
14. De Vogelaere K, Van Loo I, Peters O, et al. Laparoscopic resection of gastric gastrointestinal

stromal tumors (GIST) is safe and effective, irrespective of tumor size. Surg Endosc. 2012;26(8):2339–45.
15. Lin J, Huang C, Zheng C, et al. Laparoscopic versus open gastric resection for larger than 5 cm primary gastric gastrointestinal stromal tumors (GIST): a size-matched comparison. Surg Endosc. 2014;28(9):2577–83.
16. Huang CM, Chen QF, Lin JX, et al. Can laparoscopic surgery be applied in gastric gastrointestinal stromal tumors located in unfavorable sites?: a study based on the NCCN guidelines. Medicine. 2017;96(14):e6535.
17. Vicente E, Quijano Y, Ielpo B, et al. Robot-assisted resection of gastrointestinal stromal tumors (GIST): a single center case series and literature review. Int J Med Rob Compu Assisted Surg. 2016;12(4):718–23.
18. Buchs NC, Bucher P, Pugin F, et al. Robot-assisted oncologic resection for large gastric gastrointestinal stromal tumor: a preliminary case series. J Laparoendosc Adv Surg Tech A. 2010;20(5):411–5.
19. Desiderio J, Trastulli S, Cirocchi R, et al. Robotic gastric resection of large gastrointestinal stromal tumors. Int J Surg. 2013;11(2):191–6.
20. Andtbacka RH, Ng CS, Scaife CL, et al. Surgical resection of gastrointestinal stromal tumors after treatment with imatinib. Ann Surg Oncol. 2007;14(1):14–24.
21. Eisenberg BL, Harris J, Blanke CD, et al. Phase II trial of neoadjuvant/adjuvant imatinib mesylate (IM) for advanced primary and metastatic/recurrent operable gastrointestinal stromal tumor (GIST): early results of RTOG 0132/ACRIN 6665. J Surg Oncol. 2009;99(1):42–7.