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Robotic Gastrectomy with Lymphadenectomy for Gastric Cancer

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1. Introduction

Minimally invasive surgical approaches to early stage gastric cancer have been employed as a means to improve postoperative outcomes in patients undergoing gastrectomy for gastric cancer. However, conventional laparoscopic techniques have not gained wide acceptance due to the inherent difficulty in performing a laparoscopic gastric lymph node dissection (D2). Although laparoscopic D2 lymphadenectomy has been described and found to be feasible by experienced laparoscopic surgeons (Uyama et al. 1999, Tanimura et al. 2006, Pugliese et al. 2006), it is technically challenging and can be associated with significant bleeding during dissection around the hepatic, celiac, and splenic arteries. With increasing evidence supporting that D2 dissections can be performed with low morbidity (Wu et al. 2006, Roukos et al. 1998, Hartgrink et al. 2004), we employed robotic technology to help facilitate a minimally invasive approach to gastric lymph node dissection.

This chapter will review our operative method for performing a robotic-assisted gastrectomy with lymph node dissection. In this description, advantages and disadvantages of robotic technology will be reviewed. Our short-term post-operative and oncologic outcomes will be discussed and compared with other laparoscopic and robotic series.

2. Operative Method

Positioning and room set-up



Figure 1. Room set-up for laparoscopic portion of the procedure

Source: Medical Robotics, Book edited by Vanja Bozovic, ISBN 978-3-902613-18-9, pp.526, I-Tech Education and Publishing, Vienna, Austria

The procedure is performed under general anesthesia. An operating surgeon and one assistant perform this procedure. The patient is placed in a 30 degrees reverse Trendelenburg supine position. The first part of the operation which entails an complete omentectomy and gastric mobilization is performed laparoscopically. Robotic technology is then used to perform the lymphadenectomy and gastrointestinal reconstruction. The laparoscopic room set-up is illustrated in figure 1 with the monitors placed above the patient's head.

Port Placement

A pneumoperitoneum to 15 mmHg is established using a Veress needle technique, after which a 10-mm supra-umbilical camera port is placed. Four additional ports are placed under direct visualization: three 8-mm robotic trochars, 2 in the upper abdomen bilaterally at the midclavicular line, one in the right anterior axillary line for liver retraction, and a 10-mm assistant's port between the left robotic port and the camera port. (Fig 2).

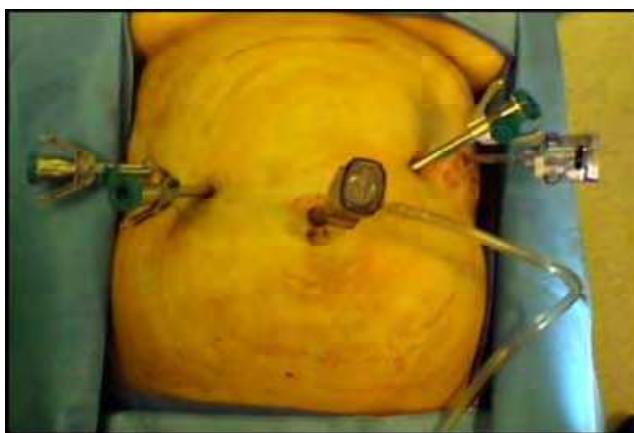


Figure 2. Port site placement

Laparoscopic Portion of Procedure

The abdomen is explored for metastatic disease, an then an on-table endoscopy is performed to identify and mark the tumor if it cannot be seen laparoscopically.



Figure 3. Intraoperative EGD

Using a harmonic scalpel an omentectomy is performed. Once completed, the lesser sac is entered and the posterior attachments of the stomach are divided. Next, the right gastroepiploic vessels are identified and divided using a vascular stapler, clips or the ultrasonic shears. (Fig 3)

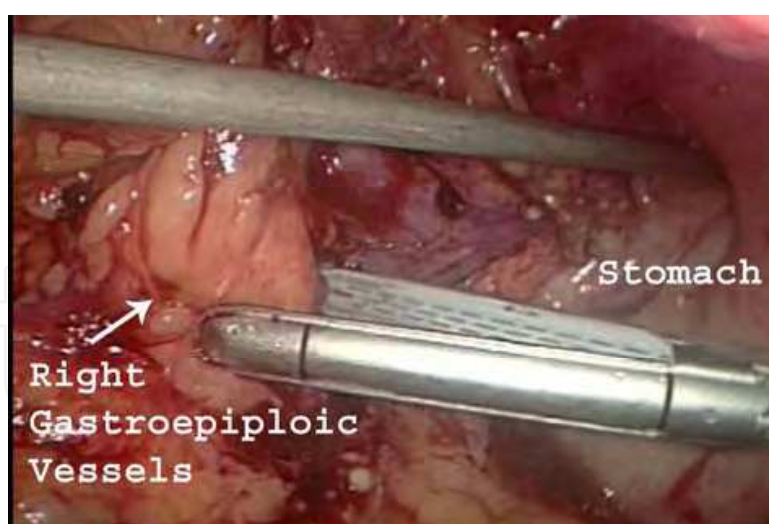


Figure 3. Staple Ligation of gastroepiploic vessels

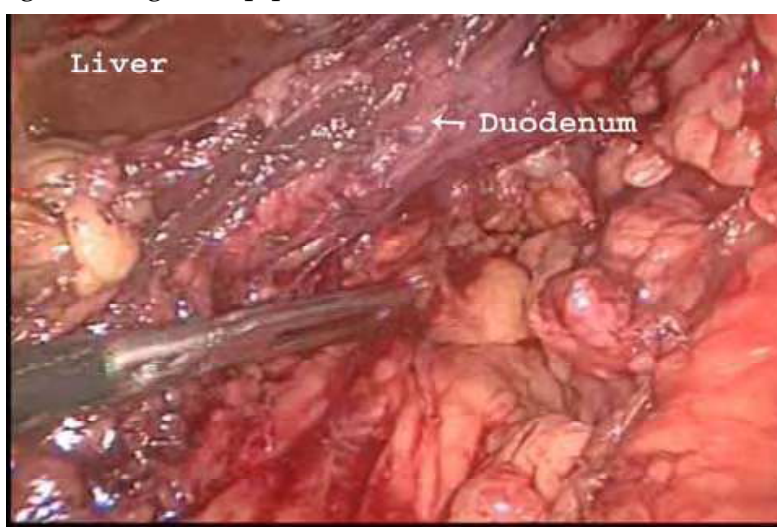


Figure 4a. Mobilized Duodenum

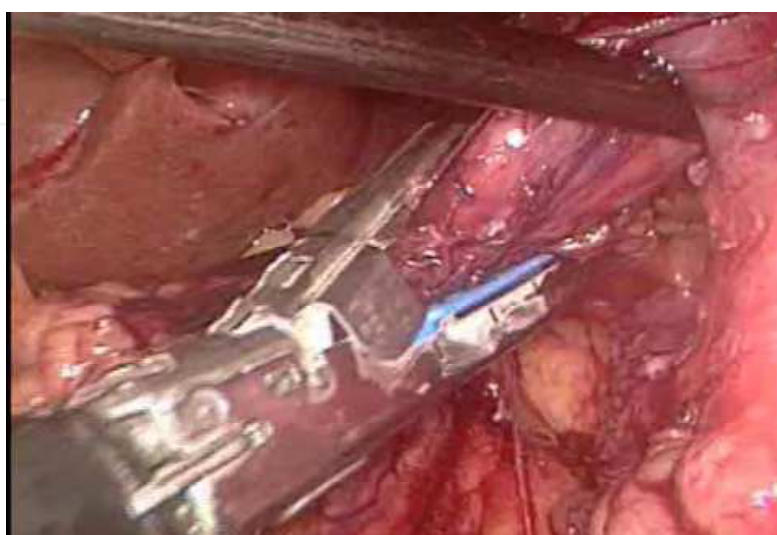


Figure 4b. Stapling of Duodenum (Blue- 3.5 mm staples)

The post pyloric duodenum is subsequently circumferentially dissected and transected using an endo-GIA stapler. (Fig 4) Infraduodenal lymph nodes are dissected and are included with the specimen during the division of the duodenum.

Robotic Portion of Procedure

A four-arm da Vinci robotic system is used. The left most lateral arm is used for liver retraction, the left midclavicular arm holds a bipolar dissector and the right robotic arm carries a fine hook cautery. A 30-degree robotic scope is used. The surgeon moves to the console and the assistant to the patient's left side. (Fig 5)



Figure 5. Robotic room-setup

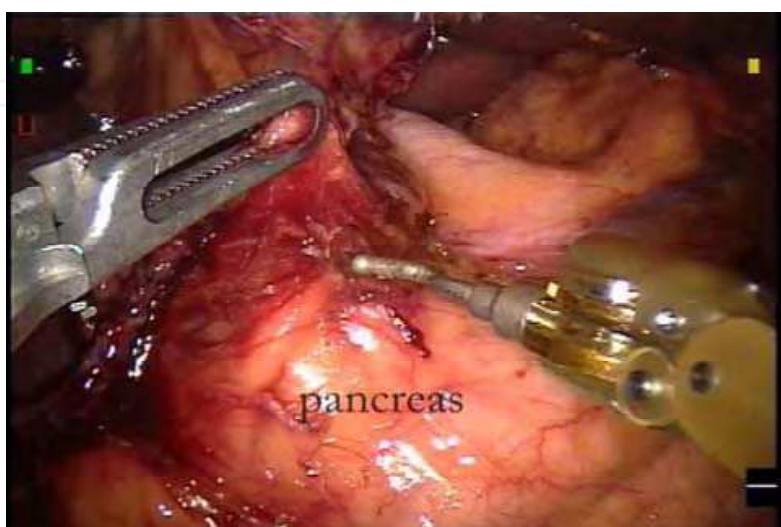


Figure 6. Beginning of lymphadenectomy

Based upon the Japanese guidelines for D2 lymphatic dissection for middle and lower gastric tumors, the following lymph node stations are harvested: stations 1- right paracardial, 3- lesser curvature, 4- greater curvature, 5- suprapyloric, 6- infrapyloric, 7- left gastric, 8- common hepatic, 9- celiac, 11- splenic, and 12- hepatoduodenal ligament. The lymphadenectomy is begun by identifying the gastroduodenal and common hepatic arteries at the superior border of the pancreas. (Fig 6)

Using hook cautery an extensive lymphadenectomy is carried out along the common hepatic artery. During this dissection the right gastric vessels are divided using endo-clips. (Fig 7) The dissection continues to the hepatic hilum until the proper hepatic artery has been completely skeletonized anteriorly. Once this has been completed the dissection continues along the common hepatic artery to the celiac trunk. (Fig 8) The left gastric vessels are ligated at their origin using either endo-clips or ties. (Fig 9) Next, the right paracardial nodes are dissected towards the specimen. (Fig 10) Subsequently, the splenic artery is skeletonized of lymphatic tissue from its origin to the splenic hilum. (Fig 11) The lymphadenectomy is completed by stripping the lesser curvature nodes of the stomach. (Fig 12)



Figure 7. Right gastric artery ligated, proper hepatic artery dissected with hook cautery



Figure 8. Dissection continuing towards celiac trunk



Figure 9. Left gastric artery ligation

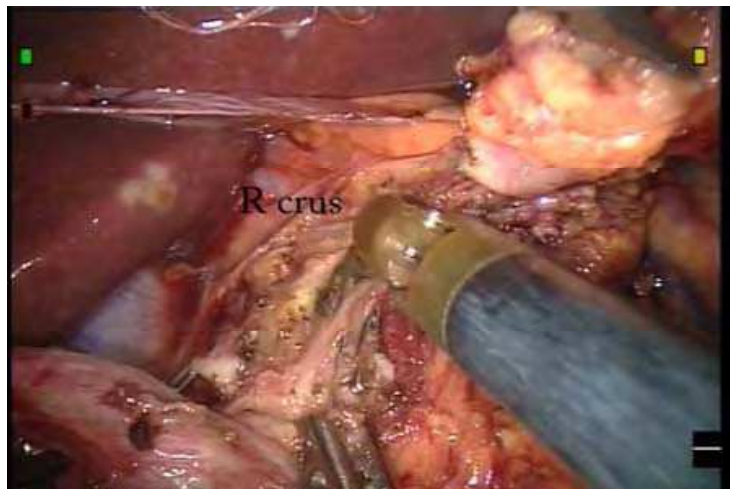


Figure 10. Right paracardial node retrieval



Figure 11. Splenic artery nodes

The resection is completed by dividing the stomach using an endo-GIA stapler (blue or green loads). This maneuver is performed by the assistant from the patient's left side. The entire specimen is placed into a large endocatch bag and removed through a suprapubic minilaparotomy incision. Gastrointestinal continuity is restored by performing a partially stapled/partially handsewn anti-colic, side-to-side gastrojejunostomy. An endo-GIA 60 stapler (blue load), is again fired from the assistant's port, creating the anastomosis. The common enterotomy is closed in a two layer hand sewn fashion with 3-0 vicryl using two robotic needle holders. Methylene blue (300ml) is injected into the stomach to test the integrity of the anastomosis.

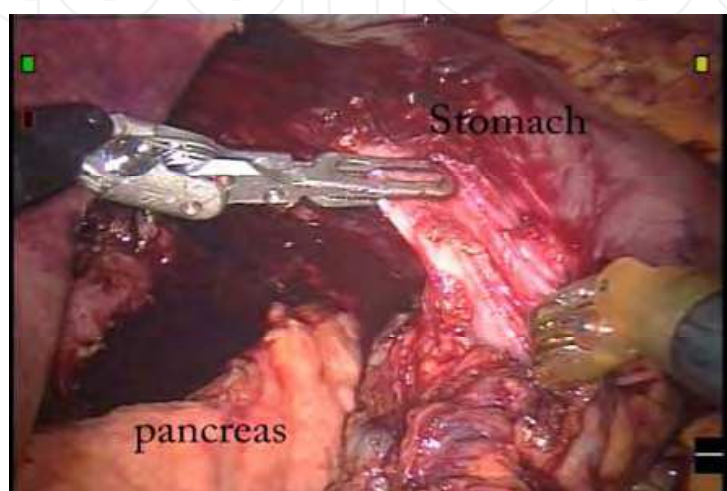


Figure 12. Lesser curvature nodes

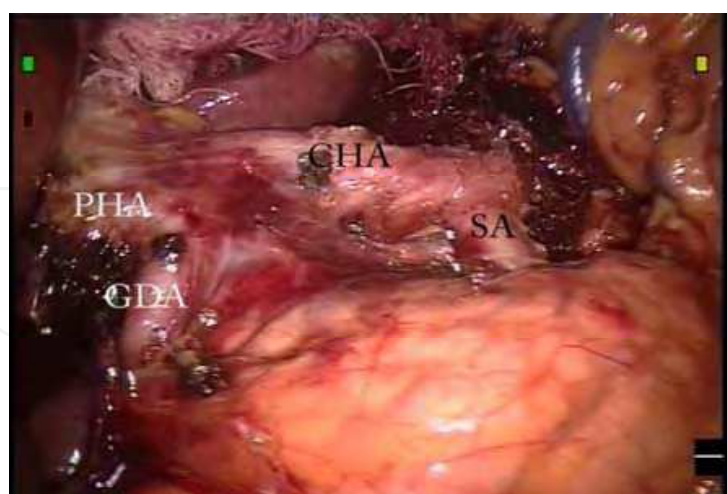


Figure 13. Completed Lymphadenectomy

3. Results

Between 7/05-2/07 ten patients with early stage gastric cancer were treated with this approach. The operative and short-term outcomes are listed in table 1.

Results	
Operative time (mins)	430 (390-459)
Estimated blood loss (ml)	300 (100-850)
# of nodes harvested	27 (17-41)
Size of tumor	1.3 (.3-3.4)
Length of Hospital stay	
Total	5 (3-9)
Intensive Care Unit	1 (0-2)
Return to diet	
Liquid	1.5 (1-6)
Solid	4 (2-8)

Table 1. Operative and short-term outcomes

The 30-day morbidity and mortality was 20%and 0% respectively. Post-operative complications included; one patient with a port site hematoma requiring transfusion, and another patient that required overnight readmission for dehydration. Additionally two patients developed deep venous thrombosis more than thirty days postoperatively.

4. Discussion

The main advantages of robot technology over conventional laparoscopy include; 3-D stereoscopic vision, the ability to tremor filter and scale motions, and the internally articulated instruments that are controlled by the robotic masters that transfer the surgeon’s hand movements to the tip of the instruments in an intuitive manner. All of these features enhance the surgeon’s ability to perform precise fine dissection. The disadvantages of the current robotic technology include the lack of tactile feedback, and difficulty operating in multiple abdominal quadrants with heavy abdominal structures. Some of these concerns may be resolved with the newest robotic model. (DaVinci S, Intuitive Surgical Inc, Sunnyvale, CA)

Table 2 lists comparative data for subtotal gastrectomies performed either laparoscopically or robotically. The largest robotic series for gastric cancer is reported by Giulianotti (Giulianotti et al., 2003). Their results are similar to those found in this report. Additionally, there are two important laparoscopic trials; one published by Lee (Lee et al., 2006) which is a large retrospective series, and the second by Huscher (Huscher et al., 2005) which is a prospective randomized trial comparing laparoscopic distal gastrectomies to open. Our robotic series compares favorable in terms of shorter hospital stays, quick return to diet, and low mortality. However, robotic operative time is longer.

Author (number of pts)	Giulianotti ² (21)	Lee ¹ (136)	Huscher ¹ (30)	Current Series ² (10)
Operative time (mins)	365	158	196	430
Lymph nodes retrieved	-	31	30	27
Length of Hospital stay	9	8	10	5
Return to diet	-	4	5	4
Morbidity	9%	8. %	23%	20%
Mortality	9%	-	3%	0%

¹ laparoscopic, ² robotic

Table 2. Comparative trials for subtotal gastrectomies

5. Conclusion

There is still limited data to support robotic surgery for management of gastric cancer. It appears to be safe and feasible technology that allows for adequate lymph node retrieval with a low morbidity and short hospital stay. If this novel therapy allows surgeons to more easily perform complex oncologic resections, then potentially this will allow more patients with gastric cancer to be managed with a minimally invasive approach.

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Medical Robotics

Edited by Vanja Bozovic

ISBN 978-3-902613-18-9

Hard cover, 526 pages

Publisher I-Tech Education and Publishing

Published online 01, January, 2008

Published in print edition January, 2008

The first generation of surgical robots are already being installed in a number of operating rooms around the world. Robotics is being introduced to medicine because it allows for unprecedented control and precision of surgical instruments in minimally invasive procedures. So far, robots have been used to position an endoscope, perform gallbladder surgery and correct gastroesophageal reflux and heartburn. The ultimate goal of the robotic surgery field is to design a robot that can be used to perform closed-chest, beating-heart surgery. The use of robotics in surgery will expand over the next decades without any doubt. Minimally Invasive Surgery (MIS) is a revolutionary approach in surgery. In MIS, the operation is performed with instruments and viewing equipment inserted into the body through small incisions created by the surgeon, in contrast to open surgery with large incisions. This minimizes surgical trauma and damage to healthy tissue, resulting in shorter patient recovery time. The aim of this book is to provide an overview of the state-of-art, to present new ideas, original results and practical experiences in this expanding area. Nevertheless, many chapters in the book concern advanced research on this growing area. The book provides critical analysis of clinical trials, assessment of the benefits and risks of the application of these technologies. This book is certainly a small sample of the research activity on Medical Robotics going on around the globe as you read it, but it surely covers a good deal of what has been done in the field recently, and as such it works as a valuable source for researchers interested in the involved subjects, whether they are currently “medical roboticists” or not.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Casandra Anderson, Joshua Ellenhorn and Alessio Pigazzi (2008). Robotic Gastrectomy with Lymphadenectomy for Gastric Cancer, Medical Robotics, Vanja Bozovic (Ed.), ISBN: 978-3-902613-18-9, InTech, Available from:
http://www.intechopen.com/books/medical_robotics/robotic_gastrectomy_with_lymphadenectomy_for_gastric_cancer

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