A Standardized Technique for Robotically Performed Sigmoid Colectomy

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ABSTRACT

Background: We describe a standardized eight-step technique to perform sigmoid colectomy using the da Vinci robot (Intuitive Surgical, Sunnyvale, CA) in both the left upper and lower abdominal quadrants.

Materials and Methods: Between March 2005 and June 2006, 11 robotic sigmoid colectomies were performed on patients with diverticulitis or cancer. The procedures were performed through 4 ports, using a medial to lateral approach and involved moving the robot during the procedure.

Results: We describe the data and results from our first 11 robotically performed sigmoid colectomies using this technique. Operative times during each step of the procedure were collected and reported. By the eighth case, our team required only 4 minutes to undock, move, and redock the robot. The average operative time was 197 minutes and the average length of hospital stay was 3.4 days. There were no complications and no conversions to open colectomy.

Conclusion: Robotically performed sigmoid colectomy is a feasible and safe procedure. The robot can be moved efficiently during surgery to allow a totally robotically performed sigmoid colectomy. The three-dimensional view, articulating instruments, intuitive movement, motion scaling, stable camera platform, and comfortable surgeon ergonomics facilitate splenic flexure mobilization and dissection and division of the inferior mesenteric artery and inferior mesenteric vein. Further studies will be needed to determine clinical benefit and economic feasibility.

INTRODUCTION

THE DA VINCI SURGICAL ROBOT (Intuitive Surgical, Sunnyvale, CA) entered the realm of general surgery following approval by the Food and Drug Administration in July 2000, and appears to be increasingly used by general surgeons throughout the country, generally for procedures that are confined to a single abdominal quadrant. Here we describe a technique of robotically performed sigmoid colectomy that requires the use of 4 ports, a medial to lateral approach, and involves moving the robot from the left upper quadrant to the left lower quadrant during the procedure. Thus, the robot is used in multiple quadrants, allowing performance of the entire procedure robotically.

MATERIALS AND METHODS

The da Vinci surgical system was used to perform 11 sigmoid colectomies between March 2005 and May 2006. Prior to incorporating the da Vinci robot in our practice...
we had performed over 500 laparoscopic colectomies. In 2004, we started performing these procedures using a medial to lateral technique.

We performed our first robotic sigmoid colectomy in March 2005 using our standard laparoscopic approach modified to enable the use of the da Vinci robot. This technique involves performing this procedure in eight steps.

We recorded the patient’s age, sex, and BMI; nursing set-up time; time from the initial skin incision to docking of the robot; time to mobilize the splenic flexure; time to undock, move, and redock the robot; time to dissect and divide the inferior mesenteric artery (IMA) and inferior mesenteric vein (IMV); time to mobilize the rectosigmoid and divide the mesorectum and rectum; the time from enlarging the umbilical incision to completion of testing the anastomosis; the total operating room time (skin to skin); length of stay; and postoperative complications.

Operating room set-up and plan

The patient is placed on the operating room table on a bean bag in a low lithotomy position. An arterial line, foley catheter, and sequential compression devices are placed. Four ports are inserted (Fig. 1). Three arms of the da Vinci robot are set up (camera, yellow, and green arms) and the robot is brought in over the patient’s left shoulder, docked to the 3 upper abdominal ports, and used to perform the splenic flexure mobilization (Fig. 2). Once the splenic flexure is mobilized, the da Vinci robot is undocked and moved over the patient’s left hip. The patient is then placed in a steep Trendelenburg position and the robot is redocked to the 3 lower abdominal ports (Fig. 3). The IMA and IMV are dissected and divided using a medial to lateral approach. The colon is then dissected off the retroperitoneum and the medial and lateral peritoneal attachments are divided. The mesorectum and rectum are then dissected and divided as well. The specimen is retrieved through an enlarged umbilical incision and the anastomosis is created using a circular EEA stapler introduced transrectally. The anastomosis is tested, the ports are removed, and the port sites are closed.

Step 1: Patient positioning and port placement

A 12-mm port is placed at the umbilicus for the camera. An 8-mm robotic port is placed in the right subcostal region between the midclavicular line and xyphoid process. Another 8-mm robotic port is placed in the left lateral mid-abdomen at a horizontal position above the level of the umbilicus, in the anterior axillary line. This port must be placed above the level of the umbilicus laterally so there will be adequate ability to reach the entire splenic flexure and also to dissect the IMA and IMV. If this port is placed too low (below the level of the umbilicus laterally) the green robotic arm will not be able to reach back to perform the IMA and IMV dissection during step 3. A 12-mm VersaStep port is placed in the right lower quadrant off the anterior superior iliac spine. This port will be the assistant’s port during the mobilization of the splenic flexure.

The patient is placed in the reverse Trendelenburg position (30–45°) with their left side up (15–30°). The robot is then brought in over the patient’s left shoulder and attached to the three upper abdominal ports. The camera arm is docked to the 12-mm umbilical port. The yellow arm (right master) is docked to the left lateral 8-mm robotic port. The green arm (left master) is docked to the right subcostal/subxiphoid 8-mm robotic port. The right lower 12-mm port is used as the assistant’s port.

Step 2: Splenic flexure mobilization

A robotic bowel grasper is placed in the green robotic arm and used to retract the proximal descending colon medially as the assistant uses a bariatric-length bowel grasper to retract the mid descending colon medially. The robotic harmonic scalpel or hook cautery is placed in the yellow robotic arm and used to mobilize the lateral peritoneal attachments of the proximal descending colon up to the splenic flexure as far as possible. The omentum is then retracted anteriorly and dissected off the distal transverse colon while working towards the splenic flexure.
FIG. 2. Operating room set-up for splenic flexure mobilization.

FIG. 3. Operating room set-up for dissection and division of the inferior mesenteric artery and inferior mesenteric vein, mobilization of the sigmoid colon, and division of the mesorectum and rectum.
Once the splenic flexure is completely mobilized away from the spleen and off Gerota’s fascia the robot is undocked from the three upper abdominal ports and backed away from the table.

**Step 3: IMA and IMV dissection and division**

The patient is placed in steep Trendelenburg position with the left side up (0–10°). The robot is then moved from the left upper quadrant to the left lower quadrant and brought in over the left hip and redocked to the three lower abdominal ports. The camera arm is redocked to the 12-mm umbilical port. The green arm (left master) is docked to the robotic 8-mm left lateral abdominal port. An 8-mm robotic port is attached to the yellow arm (right master) and telescoped into the 12-mm right lower abdominal port. The 8-mm right subcostal port is used by the assistant to retract the sigmoid mesocolon anteriorly, placing the IMA on stretch. Dissection of the IMA and IMV is performed using a medial to lateral technique. The robotic harmonic scalpel, hook, or spatula cautery is attached to the yellow arm and the Cadiere grasper is attached to the green arm. The peritoneum to the right of the IMA and inferior to the right iliac artery is opened to start the dissection. The dissection is continued working towards and over the IMA toward the left upper quadrant. The inferior mesenteric pedicle is dissected from both medial and lateral sides. The left ureter and left gonadal vessels are identified in the resulting window and preserved. Once the IMA and IMV are completely dissected, the Cadiere grasper is placed beneath the vascular pedicle with the wrist of the instrument articulated upward so the pedicle is locked into retraction to allow safe vascular transection. One must be certain the left ureter and gonadal vessels are not incorporated in the retraction. The joint release button of the yellow arm is pressed and the 8-mm robotic port is removed from the 12-mm right lower abdominal port. A 10-mm LigaSure or EndoGIA 2.0 vascular stapler is introduced through the 12-mm right lower abdominal port to divide the IMA and then the IMV. The yellow arm 8-mm port is then telescoped back into the 12-mm right lower abdominal port.

**Step 4: Posterior, medial, and lateral dissection of the rectosigmoid**

The robotic harmonic scalpel, hook, or spatula cautery and Cadiere grasper are used (as in step 3) to separate the rectosigmoid from its posterior and medial attachments down to the rectum. An avascular presacral plane along Waldeyer’s fascia is easily identified and followed. The harmonic scalpel, hook, or spatula cautery is placed into the robotic green arm and a robotic bowel grasper into the yellow arm to divide the lateral attachments of the sigmoid colon down to the rectum along the white line of Toldt.

**Step 5: Mesorectal division**

Dissection and division of the right and left mesorectum is performed. The robotic harmonic scalpel is excellent in maintaining hemostasis and is placed in the yellow arm to divide the right mesorectum and then in the green arm to divide the left mesorectum. A robotic bowel grasper or Cadiere grasper is placed in the other arm during this step.

**Step 6: Rectal transection**

The joint release button on the yellow arm is pressed and the 8-mm port is removed from the right lower abdominal 12-mm port. The EndoGIA 60-mm 3.5 roticulating stapler is passed through the 12-mm right lower abdominal port and used to transect the rectum at the level of the divided mesorectum. During this step one must verify that all attachments of the rectosigmoid are completely divided and the descending colon is free to easily reach the pelvis. The robot is then undocked and moved away from the operating room table for the remainder of the case.

**Step 7: Specimen extraction and division**

The umbilical incision is enlarged to approximately 4 cm. A wound protector is placed and the sigmoid is delivered through the umbilical wound. A purse string suture device is placed on the descending colon and the colon is transected. The specimen is sent to pathology and an EEA anvil is placed into the descending colon. The descending colon is then dropped back into the abdominal cavity. The umbilical incision is partially closed using #0 or #1 Maxon or PDS sutures and the 12-mm port is placed back through the umbilicus and pneumoperitoneum is reinstituted.

**Step 8: Anastomosis and testing**

Using conventional laparoscopic instruments, the EEA is passed transrectally and the two ends of the stapler are joined together. Being certain the colon is not twisted, the EEA is closed. The anastomosis is then performed and the donuts are inspected to be sure there are 2 complete rings. The anastomosis is tested by submerging it in a pool of irrigation fluid as a non-crushing bowel grasper is placed on the descending colon. The integrity of the anastomosis is confirmed by rigid sigmoidoscopy or by placing a foley in the rectum. Air is then pumped into the rectum to be certain there is no air leakage from the anastomosis. All irrigation, pneumoperitoneum, and ports are then removed. The fascia of the 8- and 12-mm ports are closed with 0-vicryl suture and the skin incisions closed with 4-0 Biosyn suture.
RESULTS

We summarize the surgical data of our first 11 patients undergoing robotically performed sigmoid colectomy in Table 1. In case 1, during splenic flexure mobilization, one of the two camera cords was noted to be defective, necessitating a camera change to the more magnified, narrower view camera. As a result, this step took 90 minutes. Due to our inexperience with this camera and view we were unsure of the anatomy during IMA and IMV dissection. We therefore converted this case to conventional laparoscopy and completed the case without difficulty. The other 10 cases were performed using the usual wide angle camera without further problem. In case 3, the EEA anvil was retained by the anastomosis after removing the EEA from the rectum. Rigid sigmoidoscopy was used to successfully remove the anvil from the anastomosis but resulted in this step taking 80 minutes to complete. In case 10, there was an EEA stapler misfire requiring redivision of the rectal stump and a second firing of the EEA stapler, which required 90 minutes to complete this step of the operation. In case 11, significant pelvic adhesions required additional time to divide prior to docking the robot, resulting in prolonged initial dock time of 39 minutes.

The amount of time used to undock the robot from the three upper abdominal ports, reposition the patient from reverse Trendelenburg to Trendelenburg position, move the robot over the left hip, and redock to the three lower abdominal ports improved from 20 minutes in the first case to 4 minutes by the eighth case. The average operating room time was 197 minutes (range, 145–345 minutes). The average nursing set-up time was 47 minutes and was never less than 40 minutes. The average postoperative hospital stay was 3.4 days (range, 3–4 days). There were no intraoperative or postoperative complications. The follow-up has ranged from 6 to 20 months.

DISCUSSION

Laparoscopic colectomy has replaced open colectomy as the treatment of choice for most colon conditions requiring surgical resection. As a result, we have given up certain advantages of performing open surgery. Instead of viewing the surgical field in three dimensions we view the surgical field on a two-dimension monitor. During open surgery we have the ability to bend our fingers and wrists to perform certain maneuvers that aid in dissection. During laparoscopy we use straight instruments, limiting certain aspects of dissection. The da Vinci robot gives us back some of what we lost when we made this transition to laparoscopy. The ability to view the surgical field with enhanced magnification, a three-dimensional view, a stable camera platform, and the ability to use articulating instruments with seven degrees of freedom and motion scaling has allowed us to operate more like in open surgery and in some instances with increased accuracy and precision.

The first report on robotically performed sigmoid colectomy was published in 2002. That case took 340 minutes to complete and the splenic flexure was mobilized using conventional laparoscopy. Rockall and Darzi in 2003 described their techniques in performing da Vinci robot-assisted anterior resection, abdominoperineal resection, and rectopexy. During anterior dissection they mobilize the lateral aspects of the colon with conventional laparoscopy and perform the vascular dissection.

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*The inferior mesenteric artery (IMA) and inferior mesenteric vein (IMV) were dissected via conventional laparoscopy. Steps performed using the da Vinci robot are in boldface. There were no peri- or postoperative complications in this series. BMI, body mass index; OR, operating room; LOS, postoperative hospital stay.
and division from a medial to lateral approach using the da Vinci robot. They also noted the feasibility of robot-assisted colon surgery and the advantage of enhanced surgeon vision and dexterity, which they felt may ultimately translate into better preservation of pelvic nerves and other structures. Delaney and colleagues in 2003 compared 6 laparoscopic and 6 robot-assisted colectomies, 3 of which were robotically performed sigmoid colectomies. They noted an increase in the direct cost of only $350 per case for robotically performed procedures (not including the initial cost of the robot or its maintenance). They also concluded the procedure was both feasible and safe. Hanly and Talamini in 2004 reported 202 robotically performed abdominal surgery cases, of which 35 were colon resections performed at least partially with robotic assistance. They felt the da Vinci robot was expensive and furthermore may not be useful in cases that required multiquadrant surgery. However, they claimed the da Vinci robot may offer a bridge in transitioning surgeons from open colectomy to laparoscopic colectomy. D’Annibale et al. in 2004 reported 53 robotically performed colectomies compared to 53 laparoscopic colectomies and noted no significant differences between the two groups in terms of total time of surgery, specimen length, and number of lymph nodes retrieved. They also felt the increased dexterity and three-dimensional view was particularly useful during takedown of the splenic flexure, dissection of a narrow pelvis, identification of the nervous plexus, and in performing handsewn anastomosis.

In our experience, the usefulness of the da Vinci robot was apparent during mobilization of the splenic flexure, dissection of the IMA and IMV, and while identifying important anatomical structures such as the left ureter and gonadal vessels. In our small series of 11 patients, we have been able to demonstrate the ability to perform multiquadrant robotic surgery. We were able to undock the robot from the upper three abdominal ports, reposition the patient, move the robot over the left hip, and redock the robot to the three lower abdominal ports in only 4 minutes by our eighth case.

Also, strategic port placement appears to be more important in robotically performed surgery than in conventional laparoscopy, since a misplaced port can result in the robotic arms colliding or the inability of the robotic instrument to reach the intended target. By using our port placement plan and the technique of port telescoping (the right lower abdominal port) we were able to accomplish all important aspects of the procedure through the use of only four ports.

Using this eight-step standardized technique we are able to consistently and efficiently complete the procedure. Our average operating room time was 197 minutes (range, 145–345 minutes). Excluding our first case, the average operative time for the next 10 cases was 182 minutes, which seems reasonable for laparoscopic sigmoid colectomy.

**CONCLUSION**

Our standardized approach to robotically performed sigmoid colectomy follows the traditional set-up of laparoscopic sigmoid colectomy by using four trocars, splenic flexure mobilization, a medial to lateral dissection of the IMA and IMV, transumbilical retrieval of the specimen, and an intracorporeal EEA anastomosis. The procedure is safe and feasible. The advantages for the surgeon include the ability to operate with articulating instruments, motion scaling, a stable camera platform, and a superior three-dimensional view while sitting in an ergonomically comfortable position. Larger series and more studies are needed to see if there will be an advantage for the patient using this approach.

**REFERENCES**


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