TECHNICAL NOTE

Robotic Platform for an IPAA

Amy L. Lightner, M.D. • Scott R. Kelley, M.D. • David W. Larson, M.D. M.B.A.

Division of Colon and Rectal Surgery, Mayo Clinic, Rochester, Minnesota

INTRODUCTION: An IPAA is the preferred operative approach for restoration of intestinal continuity in patients with ulcerative colitis and familial adenomatous polyposis. As minimally invasive approaches have become more widely adopted, their use in IPAA has also become increasingly commonplace. Laparoscopy has the same limitations during the proctectomy portion as seen in operations for rectal cancer, including dissection in the mid-to-lower rectum attributed to angles created by bony confines of the deep pelvis and lack of visibility when constructing the anastomosis. Robotic surgery provides improved 3-dimensional and high-definition visualization of the pelvis and multiple degrees of freedom, which greatly enhance performance during the proctectomy and construction of the anastomosis.

TECHNIQUE: In the setting of a previous subtotal colectomy, the ileostomy site is taken down and stapled across. A 15-mm balloon trocar is placed in the site to achieve insufflation, and the robotic ports are placed horizontally just above the umbilicus. The lateral mesenteric attachments are mobilized laparoscopically, then the J-pouch is constructed through the ostomy site. The J-pouch is placed back into the abdomen with the anvil in place, and the proctectomy is performed after docking the robot. The rectum is stapled with the robotic stapler and exteriorized from the ileostomy site, and the anastomosis is constructed under direct robotic visualization.

RESULTS: In addition to the potential ergonomic advantages, the maneuverability and visualization in the pelvis during the proctectomy and construction of the anastomosis are reported by many surgeons to be improved as compared with laparoscopy, especially in male or obese patients.

CONCLUSIONS: A robotic approach during the proctectomy and IPAA offers significant advantages to a laparoscopic approach, expanding our armamentarium of minimally invasive surgical techniques to IPAA.

KEY WORDS: Ileal pouch-anal anastomosis; Minimally invasive surgery; Robotic platform.

A restorative proctocolectomy with IPAA is the surgical treatment of choice for ulcerative colitis and familial adenomatous polyposis.[1,2] The operative technique has evolved over time to encompass several approaches for an IPAA including an open, hand-assisted laparoscopy; pure laparoscopy; and, more recently, a transanal approach as compared with the traditional transabdominal approach. Over the past decade, the use of laparoscopy for IPAA has increased because of the clearly described benefits, including shorter postoperative length of stay,[3,4] improved body image,[5] decreased infertility rates,[6,7] and decreased intravenous narcotic use.[3] However, limitations remain with laparoscopy largely because of the constraints of pelvic anatomy and the limitations of current laparoscopic instrumentation and camera technology.

To overcome these limitations, some surgeons have recently adopted a transanal approach for the distal rectal dissection and construction of the pouch anastomosis. Early literature suggests that this technique for IPAA is safe and may even result in fewer overall postoperative complications.[8] However, despite improved visualization of the anastomotic construction, leak rates are not lowered with this approach. The transanal technique for proctectomy is still in its infancy, and although there are limited reports suggesting equivalent postoperative outcomes,[9–11] the learning curve is long before mastering this technique.

An alternative minimally invasive approach that builds on the known techniques of laparoscopic surgery includes the use of the da Vinci robot (Intuitive Surgical Inc, Sunnyvale, CA), a minimally invasive platform that has become increasingly used in colorectal surgery for both benign and malignant conditions.[12,13] The improved dexterity,

Funding/Support: None reported.

Financial Disclosure: Dr Lightner has received consultant fees from Takeda.

Correspondence: Amy L. Lightner, M.D., Division of Colon and Rectal Surgery, Department of Surgery, Mayo Clinic College of Medicine, 200 1st St SW, Rochester, MN 55902. E-mail: Lightner.amy@mayo.edu

Dis Colon Rectum 2018; 61: 869–874
DOI: 10.1097/DCR.0000000000001125

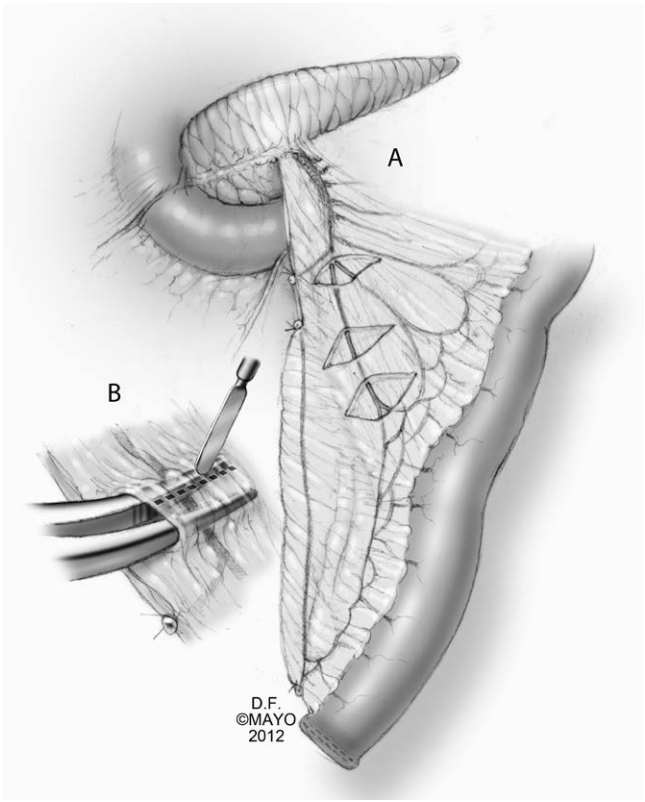

FIGURE 1. In order to increase mesenteric length, a series of stepwise incisions on the anterior and posterior mesentery can be made to increased mesenteric length (A) using electrocautery to score the mesentery superficial to the vasculature (B).

visualization, and ergonomics of the robotic platform, as well as the extensive body of literature reporting equivalent safety and efficacy outcomes as compared with conventional laparoscopy, have contributed to the surge in use of robotics for rectal cancer.[14,15] The same advantages may result in an increasing number of IPAAs performed robotically despite potential increased cost[16] and lack of hepatic feedback.[17,18] In fact, some early reports have already been published demonstrating acceptable short-term outcomes with robotic IPAA.[19,20] Therefore, we herein describe our technique for a robotic IPAA and highlight steps that may require intraoperative troubleshooting.

TECHNIQUE

Construction of the Pouch

The patient is placed into a combined lithotomy position with both arms tucked. The previously made terminal end ileostomy is dissected free from the fascia by using sharp dissection and electrocautery. Once dissected to the level of the fascia, a linear stapler is used to seal the terminal ileum. At this point, it is helpful to estimate the future pouch reach by extracting the small bowel, folding it at 15 cm, and pulling it over the pubis. Ideally the future apex of the pouch will reach ≥2 cm past the midpoint of the pubic

FIGURE 2. Construction of the 15-cm ileal pouch using linear staplers through the previously made ileostomy site.

bone. If additional mesenteric length is anticipated, stair stepping of the mesentery can be performed every 2 cm on the anterior and posterior sides of the mesentery using electrocautery as described previously (Figs. 1A and B).[21] The ileal pouch is then constructed. Approximately 15 to 20 cm proximal from the distal ileal staple line, the bowel is opened on the antimesenteric side with the use of electrocautery. This marks the apex of the pouch. A 15- to 20-cm J-pouch is constructed using 2 fires of the 100-mm extracorporeal linear stapler (GIA100, Covidien, Boulder, CO). A 2-0 Prolene (Ethicon, Inc, Somerville, NJ) is placed as a pursestring suture, and the anvil to the circular stapler (EEA 28 or 29 mm, depending on the product used) is placed into the apex (Fig. 2). The blind limb of the pouch and the linear staple line are then oversewn with 3-0 silk sutures. The anvil and pouch are then dropped back into the abdomen, and a 15-mm balloon trocar is placed into the ileostomy site as an additional working port.

Insufflation is achieved through the 15-mm balloon trocar. Four robotic ports are placed under direct visualization in a transverse fashion across the abdomen ≈15 cm from the pubis; each trocar is placed 6 to 8 cm apart in order for the Xi system to avoid external or internal collisions. An additional 5-mm working port can also be placed in the lower midline or left upper quadrant if necessary and one encounters a difficult mobilization of the mesentery; the AirSeal device can be attached to one of these ports when used (Fig. 3).

Mobilization of the Mesentery

An important tenant of pouch surgery is to create the anastomosis without tension. Thus, a critical step is adequate mobilization of the mesentery. Using the robotic ports, the ileal attachments around the second to fourth portion of the duodenum are taken laparoscopically (Fig. 4A), making sure to identify and protect the superior mesenteric vein and artery (Fig. 4B). During this step, the ileocolic artery may be divided in a high ligation fashion if this has

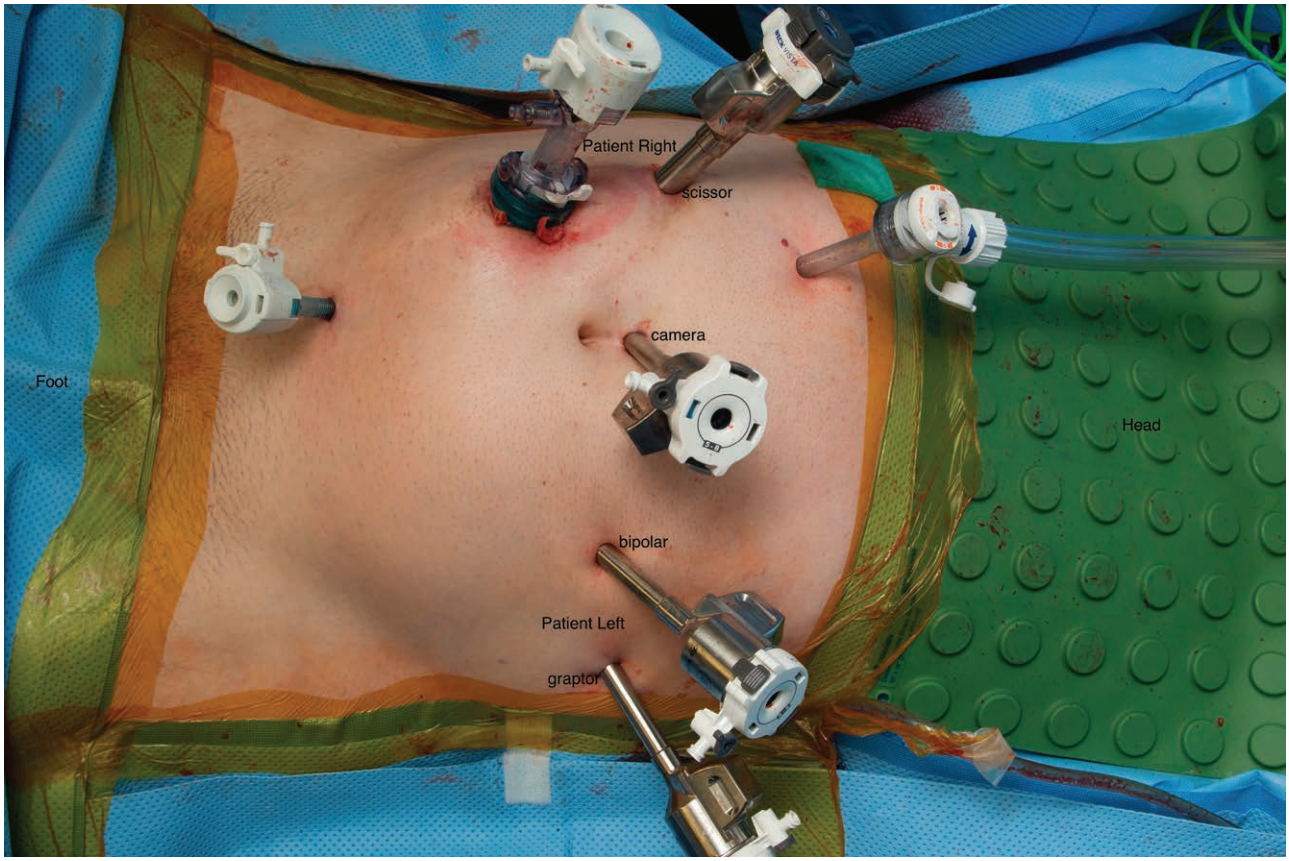

FIGURE 3. Placement of 4 robotic ports and 15-mm balloon trocar (working port) in the abdomen. Additional 5-mm working ports may be placed as necessary.

not been done at the time of subtotal colectomy and mesenteric length is a concern. Another key step is division of the distal branches of the superior mesenteric artery for additional mesenteric length. We typically perform this step after placing a bulldog vascular clamp to ensure adequate perfusion to the ileum before ligation of the vessels.

Proctectomy

Once the mesenteric mobilization is completed, attention is turned to the proctectomy portion of the operation. The robot device (da Vinci Surgical System, Intuitive Surgical Inc) is docked on the patient's left lateral side (Fig. 5). The patient is placed into a steep Trendelenburg position to allow the small bowel to fall cephalad, exposing the pelvis. Scissors are placed in arm 1, camera in arm 2, bipolar fenestrated in arm 3, and small graptor in arm 4 (from patient right to left).

The top of the rectal stump is identified, the sacral promontory is identified, and the ureter and iliac vessels are on the right side. The proctectomy begins by entering the presacral space from the right side. The posterior dissection is performed first, ensuring that the superior hypogastric nerves are identified during the dissection and preserved by gently sweeping them posteriorly toward the sacrum. The lateral stalks are taken, and the mesentery (which includes the remaining superior rectal artery) is divided using the da Vinci EndoWrist One Vessel Sealer (Intuitive Surgical Inc). The anterior dissection is performed last. Arm 3 is used to pull the rectal stump down and out of the pelvis to provide proper tension on the anterior structures. The assistant aids the dissection by placing a suction device or grasper anterior at the level of the seminal vesicle or posterior vagina and lifting anteriorly. This countertraction anterior to the rectum allows the dissection to progress just posterior to Dennonvilliers' fascia to the level of the pelvic floor (Fig. 6). Once the pelvic floor is identified, the rectum is digitized transanally to determine adequate dissection and to ensure that the anastomosis will be performed just above the anorectal junction, being careful not to catch the sphincter complex in the stapler. The rectum is transected using 2 to 3 fires of the da Vinci EndoWrist 45-mm stapler (Intuitive Surgical Inc; Fig. 7) and the specimen extracted through the ileostomy site after the IPAA has been stapled to the anal canal and before loop ileostomy creation.

Construction of the Anastomosis

After moving the transected rectum out of the pelvis, the pouch is connected to the anus under robotic visualiza-

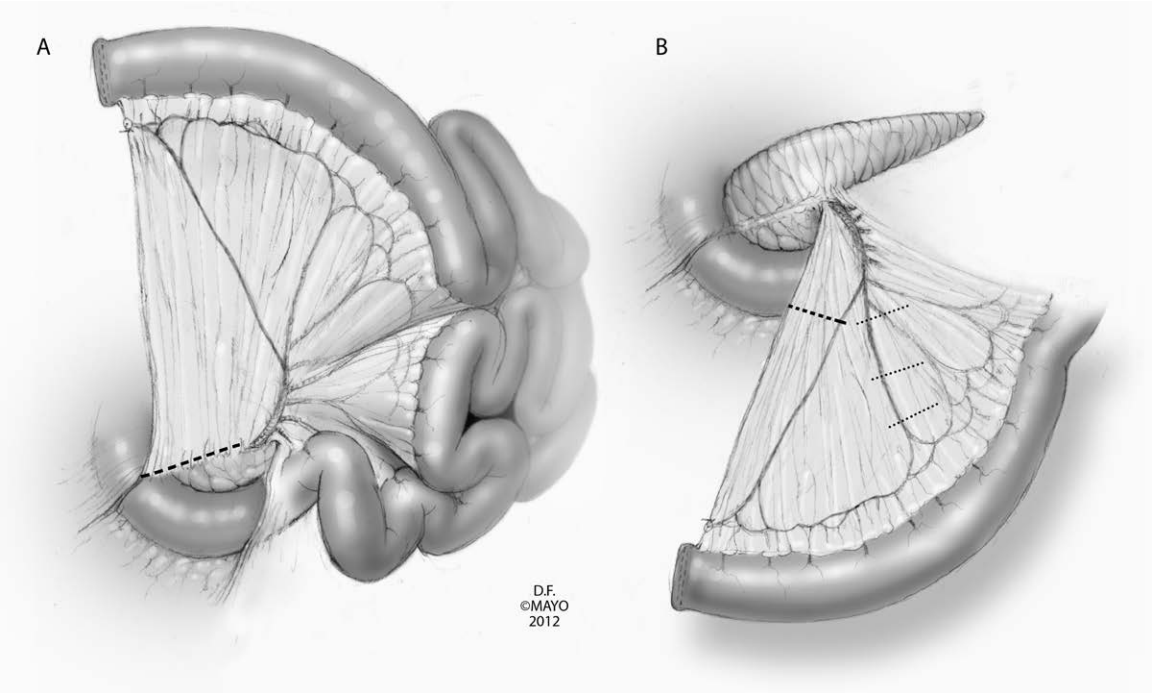

FIGURE 4. The first step in mesenteric mobilization is mobilizing the lateral attachments cephalad until the inferior border of the duodenum and pancreas are reached (A), making sure to identify and protect the superior mesenteric artery (B).

tion. Under robotic control, the pouch and the anvil are brought toward the pelvis. A series of rectal dilators are inserted into the anal canal followed by the EEA 28- or 29-mm stapler, depending on the stapler. The stapler pin is deployed and married to the anvil under direct robotic visualization (Fig. 8).

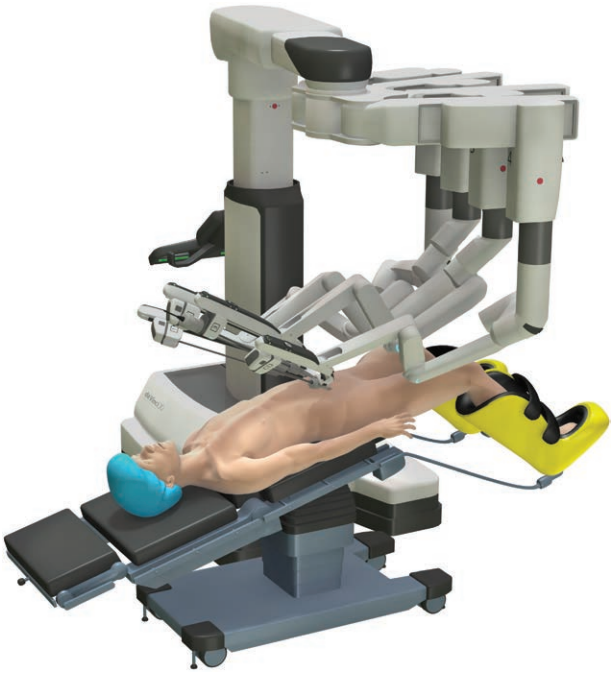

FIGURE 5. The robot device (da Vinci Surgical System, Intuitive Surgical Inc) is then docked on the patient's left lateral side.

Testing the Anastomosis

Once the pouch has been successfully connected to the anus, the patient is placed into reverse Trendelenburg and irrigation is placed into the pelvis. Proctoscopic visualization and insufflation of the pouch under saline assure the surgeon that there are no leaks.

Diverting Loop Ileostomy

Before construction of the diverting loop, the rectum is removed through the ileostomy site. A diverting loop il-

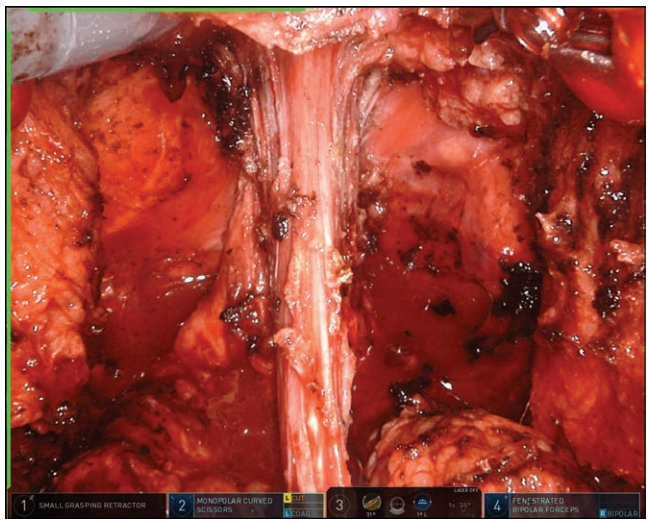

FIGURE 6. On completion of the posterior, anterior, and lateral dissections, the rectum should be skeletonized at the level of the pelvic floor before firing the robotic stapler.

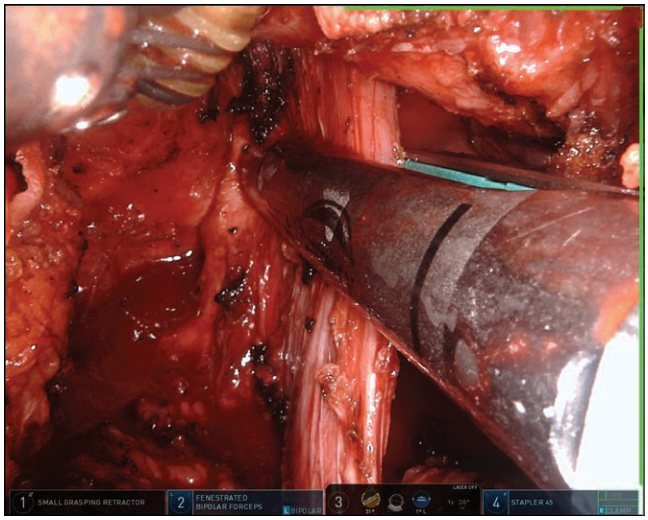

FIGURE 7. Firing the 45-mm green load robotic stapler across the lower rectum just above the pelvic floor.

eostomy is constructed in the previous ileostomy site to protect the IPAA. A location proximal to the pouch inlet that allows no tension to be placed on the pouch is used for stoma creation. This is typically 25 to 50 cm proximal from the pouch inlet. A 19-F Jackson-Pratt drain (Cardinal Health, Dublin, OH) is then placed through the left-sided robotic trocar site into the pelvis.

CONCLUSION

A robotic approach provides another technique for a minimally invasive approach to IPAA. Although there are no randomized controlled trials comparing robotic and laparoscopic IPAA, potential advantages include improved angulation of instrumentation for the narrow space within the pelvis, superior visualization of the autonomic nerve bundles in the pelvis, and improved ergonomics. The robot is yet another minimally invasive tool for IPAA construction and may be preferred by some surgeons over time to laparoscopy.

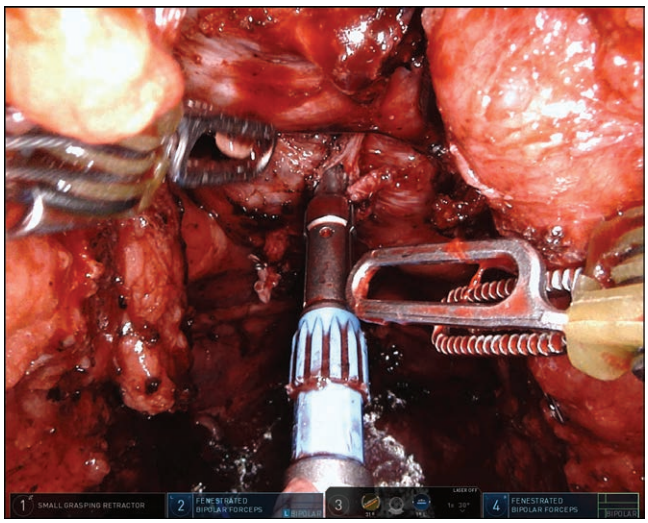

FIGURE 8. Constructing the IPAA intracorporeally under direct robotic visualization. Bringing the anvil into view; beginning to close the stapler.

REFERENCES

1. Fazio VW, Ziv Y, Church JM, et al. Ileal pouch-anal anastomoses complications and function in 1005 patients. *Ann Surg.* 1995;222:120–127.
2. Parks AG, Nicholls RJ. Proctocolectomy without ileostomy for ulcerative colitis. *BMJ.* 1978;2:85–88.
3. Larson DW, Cima RR, Dozois EJ, et al. Safety, feasibility, and short-term outcomes of laparoscopic ileal-pouch-anal anastomosis: a single institutional case-matched experience. *Ann Surg.* 2006;243:667–670.
4. White I, Jenkins JT, Coomber R, Clark SK, Phillips RK, Kennedy RH. Outcomes of laparoscopic and open restorative proctocolectomy. *Br J Surg.* 2014;101:1160–1165.
5. Ahmed Ali U, Keus F, Heikens JT, et al. Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis. *Cochrane Database Syst Rev.* 2009;(1):CD006267.
6. Bartels SA, D'Hoore A, Cuesta MA, Bensdorp AJ, Lucas C, Bemelman WA. Significantly increased pregnancy rates after laparoscopic restorative proctocolectomy: a cross-sectional study. *Ann Surg.* 2012;256:1045–1048.
7. Beyer-Berjot L, Maggiori L, Birnbaum D, Lefevre JH, Berdah S, Panis Y. A total laparoscopic approach reduces the infertility rate after ileal pouch-anal anastomosis: a 2-center study. *Ann Surg.* 2013;258:275–282.
8. de Buck van Overstraeten A, Mark-Christensen A, Wasmann KA, et al. Transanal versus transabdominal minimally invasive (completion) proctectomy with ileal pouch-anal anastomosis in ulcerative colitis: a comparative study. *Ann Surg.* 2017;266:878–883.
9. Perdawood SK, Al Khefagie GA. Transanal vs laparoscopic total mesorectal excision for rectal cancer: initial experience from Denmark. *Colorectal Dis.* 2016;18:51–58.
10. Perdawood SK, Thinggaard BS, Bjoern MX. Effect of transanal total mesorectal excision for rectal cancer: comparison of short-term outcomes with laparoscopic and open surgeries. *Surg Endosc.* 2018;32:2312–2321.
11. Simillis C, Hompes R, Penna M, Rasheed S, Tekkis PP. A systematic review of transanal total mesorectal excision: is this the future of rectal cancer surgery? *Colorectal Dis.* 2016;18:19–36.
12. Yang Y, Wang F, Zhang P, et al. Robot-assisted versus conventional laparoscopic surgery for colorectal disease, focusing on rectal cancer: a meta-analysis. *Ann Surg Oncol.* 2012;19:3727–3736.
13. Juo YY, Hyder O, Haider AH, Camp M, Lidor A, Ahuja N. Is minimally invasive colon resection better than traditional approaches?: First comprehensive national examination with propensity score matching. *JAMA Surg.* 2014;149:177–184.
14. Trinh BB, Jackson NR, Hauch AT, Hu T, Kandil E. Robotic versus laparoscopic colorectal surgery. *JSLS* 2014;18.
15. Kim MJ, Park SC, Park JW, et al. Robot-assisted versus laparoscopic surgery for rectal cancer: a phase II open label prospective randomized controlled trial. *Ann Surg.* 2018;267:243–251.

16. Tyler JA, Fox JP, Desai MM, Perry WB, Glasgow SC. Outcomes and costs associated with robotic colectomy in the minimally invasive era. *Dis Colon Rectum*. 2013;56:458–466.
17. Rawlings AL, Woodland JH, Vegunta RK, Crawford DL. Robotic versus laparoscopic colectomy. *Surg Endosc*. 2007;21:1701–1708.
18. Bertani E, Chiappa A, Biffi R, et al. Assessing appropriateness for elective colorectal cancer surgery: clinical, oncological, and quality-of-life short-term outcomes employing different treatment approaches. *Int J Colorectal Dis*. 2011;26:1317–1327.
19. Mark-Christensen A, Pachler FR, Nørager CB, Jepsen P, Laurberg S, Tøttrup A. Short-term outcome of robot-assisted and open IPAA: an observational single-center study. *Dis Colon Rectum*. 2016;59:201–207.
20. Pedraza R, Patel CB, Ramos-Valadez DI, Haas EM. Robotic-assisted laparoscopic surgery for restorative proctocolectomy with ileal J pouch-anal anastomosis. *Minim Invasive Ther Allied Technol*. 2011;20:234–239.
21. Baig MK, Weiss EG, Nogueras JJ, Wexner SD. Lengthening of small bowel mesentery: stepladder incision technique. *Am J Surg*. 2006;191:715–717.