SCIENTIFIC PAPER JSLS

Robotic Versus Laparoscopic Resection for Mid and Low Rectal Cancers

Abdulkadir Bedirli, MD, Bulent Salman, MD, Osman Yuksel, MD

ABSTRACT

Background and Objectives: The current study was conducted to determine whether robotic low anterior resection (RLAR) has real benefit over laparoscopic low anterior resection (LLAR) in terms of surgical and early oncologic outcomes.

Methods: We retrospectively analyzed data from 35 RLARs and 28 LLARs, performed for mid and low rectal cancers, from January 2013 through June 2015.

Results: A total of 63 patients were included in the study. All surgeries were performed successfully. The clinicopathologic characteristics were similar between the 2 groups. Compared with the laparoscopic group, the robotic group had less intraoperative blood loss (165 vs. 120 mL; $P < .05$) and higher mean operative time (252 vs. 208 min; $P < .05$). No significant differences were observed in the time to flatus passage, length of hospital stay, and postoperative morbidity. Pathological examination of total mesorectal excision (TME) specimens showed that both circumferential resection margin and transverse (proximal and distal) margins were negative in the RLAR group. However, 1 patient each had positive circumferential resection margin and positive distal transverse margin in the LLAR group. The mean number of harvested lymph nodes was 27 in the RLAR group and 23 in the LLAR group.

Conclusion: In our study, short-term outcomes of robotic surgery for mid and low rectal cancers were similar to those of laparoscopic surgery. The quality of TME specimens was better in the patients who underwent robotic surgery. However, the longer operative time was a limitation of robotic surgery.

Key Words: Laparoscopic rectal surgery, Robotic rectal surgery.

INTRODUCTION

Laparoscopic surgery has been widely practiced for benign and malignant colorectal diseases since laparoscopy-assisted colorectal surgery was first performed in 1991.[1] Oncological accuracy and minimally invasive advantages, such as less pain, shorter length of stay, and faster return of bowel function, are provided by laparoscopic surgery, compared with open surgery.[2,3] Robotic surgery, the latest technological development in minimally invasive surgical options, was first identified in 2002 by Weber et al,[4] who reported the first robot-assisted colectomy procedure in the literature. To date, several clinical series have been presented on the implementation of robotic surgery, together with the already established method of laparoscopic surgery.[5–7] The early and late results of these methods for right and left colon cancers propose that both methods can be used effectively and safely in colon cancer.[5,8] However, the clinical results of both approaches in rectal cancers and for total mesorectal excision (TME) are still noteworthy.[7,9] Standard laparoscopic TME is a technically difficult procedure to perform in the pelvis, where the sense of depth is decreased, and the space is anatomically limited. Robotic surgery then becomes a viable alternative to laparoscopic surgery for minimally invasive treatment of rectal cancer, owing to 3-dimensional (3-D) magnification and the stable camera, articulated robotic instruments, and reduction of physiologic tremor in the pelvis. For years, we have performed laparoscopic surgeries for the treatment of rectal cancers; we have used the robotic method since 2013. The purpose of this study was to compare the outcomes of patients who underwent low anterior resection (LAR) by either the robotic (RLAR) or laparoscopic (LLAR) method for mid and low rectal cancers.

MATERIALS AND METHODS

The records of patients who had undergone LAR with either the laparoscopic or robotic method from January

Gazi University Medical Faculty, Department of General Surgery, Ankara, Turkey (all authors).

Author contributions: A.B. conceived and designed the procedure, performed the operations, revised the article, and approved the final version of the manuscript; B.S. assisted in the operation; and O.Y. drafted and edited the article.

Address correspondence to: Abdulkadir Bedirli, MD, Gazi University Medical Faculty, Department of General Surgery, Ankara, Turkey. Telephone: +90 312 2025724, Fax: +90 312 2150494, E-mail: bedirlia@gazi.edu.tr

DOI: 10.4293/JSLS.2015.00110

2013 through June 2015 were reviewed. Patients who had cancers of the upper one-third of the rectum, did not receive neoadjuvant radiotherapy, had early stage (Tis and T1 tumors), had synchronous colorectal cancer, or had distant organ metastasis were excluded from the study. All patients underwent chest radiography, abdominopelvic computed tomography (CT), and pelvic magnetic resonance (MR). Pelvic MR was repeated after neoadjuvant radiotherapy. Chest CT or positron emission tomography (PET) was used as necessary. Age, sex, date of operation, operative procedure, histopathologic findings, neoadjuvant and/or adjuvant chemoradiotherapy, body mass index (BMI), and tumor localization were obtained from the patient records. This study was performed at 1 institution, and both the conventional laparoscopic and robotic approaches were managed by the same primary surgeon (A.B.) in all cases. All patients underwent preoperative mechanical bowel preparation, and received prophylactic antibiotics just before the surgery. The LLAR method was performed as has been described.[10] For the RLAR method, the da Vinci SI Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) was used. After administration of general anesthesia, the patient was placed in the modified Lloyd-Davis position. We performed an RLAR without changing the position of the robotic cart, but the robotic arms were repositioned between the abdominal and pelvic phases, as described by Choi et al.[11] The port placements for a single-docking RLAR are presented in **Figures 1** and **2**. The procedure was initiated from the sacral promontorium. Dissection continued upward, and the inferior mesenteric artery was attached with Hem-o-lok clips (Hem-o-lok Ligation System; Teleflex, Morrisville, NC, USA) and cut. Dissection was completed from behind the mesocolon and laterally toward the bottom of the pancreas, the lesser sac was revealed, and 1 sponge was placed in this region. The inferior mesenteric vein was then attached with Hem-o-lok clips and cut after the mesocolon dissection. For transverse colon mobilization, we progressed to the splenic flexure by using robotic arms 1 and 2, and the splenic flexure was mobilized until the sponge was placed in the lesser sac. The white line of Toldt was then revealed, and the pelvic distance was reached through the Toldt fascia.

Robotic arms 2 and 3 were reconnected; arm 3 was connected to the left upper quadrant port and arm 2 was connected to the left lower quadrant port. After the robotic arms were repositioned, the mesorectum was dissected from the promontorium in the presacral plane. The right lateral ligament was revealed first. After the posterior right dissection was completed, the left lateral dissection was initiated. An incision was made in the anterior region, and dissection was continued along the rectovaginal septum in women or under the seminal vesicles in men. At this stage, the pelvic fold was attached to the anterior abdominal wall with 1 or 2 sutures. As a result, greater anterior visibility was obtained. After the TME was completed, the distal rectum was closed with an intestinal clamp and washed with povidone iodine from the anal region. The distal rectum was then transected with a 45-mm linear stapler.

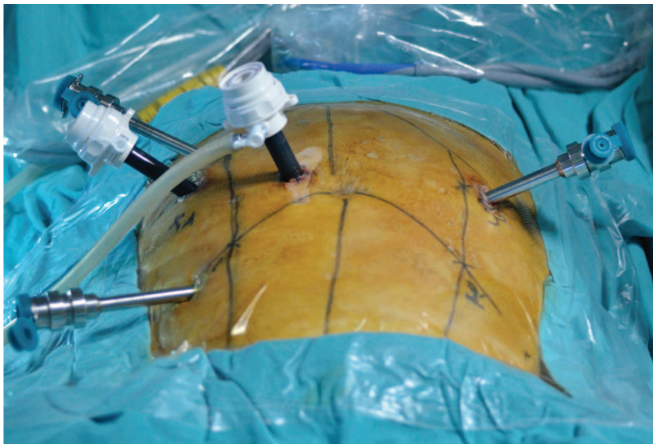

Figure 1. Port placement, abdominal phase: vascular ligation, splenic flexure mobilization, and sigmoid mobilization.

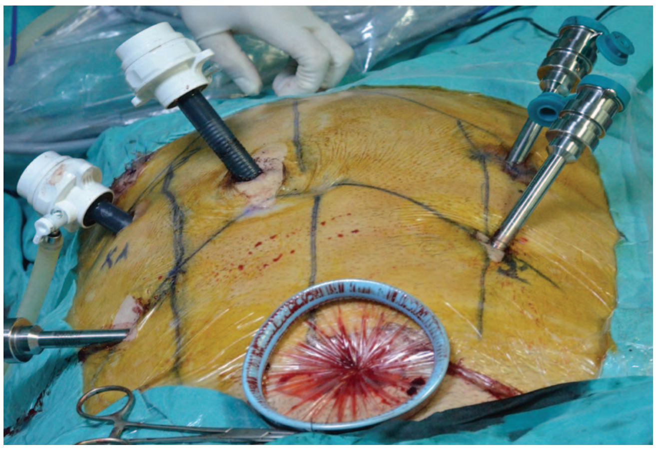

Figure 2. Port placement, pelvic phase: pelvic total mesorectal excision and transabdominal specimen extraction through an Alexis wound retractor.

The proximal colon was then removed with the help of the Alexis retractor, which was placed from the suprapubic incision (4–5 cm). A proximal transection was performed extracorporeally, a circular stapler anvil was placed inside the bowel and closed with a purse-string suture, and the bowel was placed into the abdomen. Reinsufflation was achieved after rotation of the Alexis retractor. End-to-end anastomosis was achieved with a circular stapling device. After an air test, the procedure was concluded with the placement of a silicone drain.

Outcome Measures and Statistical Analyses

Clinicopathological characteristics, postoperative outcomes, hospital stay, postoperative morbidity and mortality, and short-term oncologic outcomes, including the number of lymph nodes retrieved, the distal margin, radial margin, and pathological staging were compared. The mean values were compared by using the paired and unpaired Student's *t* test. Frequency and distribution were compared by using the χ^2 test. Statistical significance was assumed at $P < .05$. These analyses were performed with SPSS 10.0 software (SPSS, Chicago, IL, USA).

RESULTS

Over the 2.5-year study period, LARs for low rectal cancer were performed with the robotic method in 35 patients and with the laparoscopic method in 28. The mean follow-up period was 9.7 months (range, 2–30). Demographic characteristics of the study patients are shown in **Table 1**. Of the 63 patients, 20 were female and 43 were male, and the mean age was 63 years. All patients underwent preoperative, long-term 4500 cGy-fractionated radiotherapy. A total of 19 patients (54%) in the RLAR group and 13 patients (46%) in the LLAR group received neoadjuvant chemotherapy, concomitantly. The patients underwent robotic or laparoscopic surgery 7 wk after completing radiotherapy. The protective ileostomy was opened in all patients from both groups after LAR. No significant difference in demographic characteristics was observed between the groups ($P > .05$).

The mean operative time in the LLAR group was shorter than that in the RLAR group, and the difference was significant (208 and 252 min, respectively; $P = .027$). The mean intraoperative blood loss was 120 mL in the RLAR group and 165 mL in the LLAR ($P = .034$) group. No significant difference was observed between the groups in the postoperative start time of bowel movements or start time of liquid and normal diets ($P > .05$). The mean length of stay in the intensive care unit (ICU) was longer in the RLAR group than in the LLAR ($P < .05$) group. In contrast, the total length of hospital stay of patients in both groups was similar (**Table 2**). Three patients in the robotic group were admitted to the ICU after the operation, because of the prolonged time needed for extubation.

Table 1.
Patient Characteristics

Characteristics	RLAR Group (n = 35)	LLAR Group (n = 28)	*P**
Age (y), mean ± SD	64.7 ± 8.5	60.4 ± 7.1	NS
Sex, n (male/female)	24/11	19/9	NS
ASA level			NS
I	6 (17)	4 (14)	
II	17 (49)	15 (54)	
III	12 (34)	9 (32)	
BMI, mean ± SD	24.7 ± 3.9	23.2 ± 3.2	NS
Previous abdominal surgery	8 (23)	9 (32)	NS
Neoadjuvant radiotherapy	35 (100)	28 (100)	NS
Neoadjuvant chemotherapy	19 (54)	13 (46)	NS
Protective ileostomy	35 (100)	28 (100)	NS

Data are expressed as number of patients (% of total group), unless otherwise specified. NS, not significant; ASA, American Society of Anesthesiologists.

*χ^2 test.

Table 2.
Operative and Postoperative Results

Results	RLAR Group (n = 35)	LLAR Group (n = 28)	*P*
Operation time (min)	252 ± 62	208 ± 49	0.027*
Operative blood loss (mL)	120 ± 15	165 ± 40	0.034*
Time to flatus (d)	1.8 ± 1.5	1.6 ± 1.1	NS
Time to liquid diet (d)	2.3 ± 1.4	2.2 ± 1.8	NS
Time to normal diet (d)	3.6 ± 2.7	3.2 ± 2.5	NS
Stay in ICU (d)	1.8 ± 1.1	0.9 ± 0.4	0.019*
Total hospital stay (d)	5.1 ± 3.7	4.6 ± 2.8	NS

Data are expressed as the mean ± SD. NS, not significant. ICU, intensive care unit.

* Student's *t* test.

Anastomotic leakage was observed in 4 patients (2 patients in each group), during the postoperative period, as a major surgical complication (6.4% for the whole series). Wound infection was also observed in the suprapubic incision: specimens were taken from 2 patients in the RLAR group (6%) and from 3 in the LLAR group (11%). No

Table 3.
Postoperative Morbidity and Mortality

Complication	RLAR Group (n = 35)	LLAR Group (n = 28)	*P*
Surgical site infection	2 (6)	3 (11)	NS
Anastomotic leakage	2 (6)	2 (7)	NS
Postoperative ileus	1 (3)	-	NS
Major medical complication	2 (6)	3 (11)	NS
Pneumonia	1 (3)	1 (4)	
Cardiac decompensation	-	1 (4)	
Myocardial infarction	1 (3)	-	
Renal failure	-	1 (4)	
Operative mortality	-	-	NS

Data are expressed as number of patients (% of total group). NS, not significant.

mortality occurred in either group, and no significant difference was observed between the groups in postoperative complications ($P > .05$) (**Table 3**).

Tumor location was evaluated by performing rigid proctosigmoidoscopy. Distance of the tumor from the anal verge was between 0 and 6 cm in 46% patients in the RLAR group and in 29% patients in the LLAR group. In contrast, distance between the tumor and the anal verge was 7–12 cm in 19 patients (54%) in the RLAR group and in 20 patients (71%) in the LLAR group ($P < .05$). In histopathological examinations of the specimens, there was no distal margin, but circumferential involvement of less than 1 mm, was seen in 1 patient in the RLAR group, and distal margin and circumferential involvement was seen in 1 patient in the LLAR group. Tumor stage III was the most frequently encountered in histopathological evaluations of the RLAR and LLAR groups (54% and 61%, respectively). The number of dissected lymph nodes was greater in the RLAR group than in the LLAR group (mean, 27 and 23, respectively), but this difference was not significant ($P > .05$). Moreover, no significant difference was observed between the groups for the histopathological typing of the tumors ($P > .05$) (**Table 4**).

DISCUSSION

Within 2.5 years, 63 patients at our clinic underwent LAR for lower rectal cancer, with either the robotic (35 patients) or the laparoscopic (28 patients) method. A comparison showed that longer operative time, decreased blood loss, and longer length of stay in the ICU were typical of patients in the RLAR group. No difference was observed between the groups for surgical complications and oncologic outcomes (number of dissected lymph nodes, distal margin, and circumferential margin involvement). Evaluating the early results of our study, either RLAR or LLAR can be used safely for the surgical management of mid and low rectal tumors.

Laparoscopic surgery has become a standard approach for the treatment of colon cancer because of the lower analgesic requirement, shorter length of hospital stay, and decreased blood loss and postoperative ileus. However, the application of laparoscopic surgery for rectal cancer is still controversial. Considering early studies, it is noteworthy that laparoscopic rectal cancer surgery has higher rates of conversion to open surgery and more frequent circumferential, distal, and proximal resection margin involvement, compared to open surgery.[12] However, large randomized studies conducted over the past 10 years have proposed that laparoscopic surgery can be performed safely in rectal cancer, with all the beneficial advantages of minimally invasive surgery and with better oncologic results.[13,14] As such, laparoscopic TME is performed increasingly, because its benefits are not less than those of open surgery, especially in long-term oncologic outcomes.[15] Nevertheless, despite all the aforementioned advantages, laparoscopic TME is a difficult procedure, even for experienced surgeons. For this reason, laparoscopic TME is still the less frequently preferred option worldwide, as opposed to an open TME for rectal cancer.[16] The challenges associated with a laparoscopic TME include processing in the pelvis, which is an anatomically difficult space; limitations of the laparoscopic instruments when used in a confined space; having decreased sense of depth; and the need for a camera assistant who can work in coordination with the surgeon.

The multiarticulation and high rotation capacity of the instruments used in a robotic surgery and high-resolution 3-D robotic cameras controlled by the surgeon are important for rectal surgery. The advantages brought about by robotic technology have led to its increased use in the surgical treatment of rectal cancer.[7,9] Baek et al[17] reported, in a series including 182 patients with rectal cancer, that robotic technology provides comfort to surgeons with regard to navigating pelvic anatomies of various difficulties. However, the contemporary issue is to determine the advantages and disadvantages of the laparoscopic and robotic methods, relative to each other, for TMEs performed in the pelvic space. On reviewing randomized controlled studies, we observed that both methods have similar advantages provided by minimally invasive sur-

Table 4.
Comparison of the Tumor Characteristics and Pathologic Parameters

Characteristics and Pathologic Parameters	RLAR Group (n = 35)	LLAR Group (n = 28)	*P*
Tumor distance from AV, cm			0.046
0–6	16 (46)	8 (29)	
7–12	19 (54)	20 (71)	
Distal margin involvement	0 (0)	1 (4)	NS
Circumferential margin involvement	1 (3)	1 (4)	NS
Stage			NS
II	13 (37)	9 (32)	
III	19 (54)	17 (61)	
IV	3 (9)	2 (7)	
Number of lymph nodes, mean ± SD	27 ± 11	23 ± 8	NS
Histology			NS
Well-differentiated adenocarcinoma	8 (23)	7 (25)	
Moderately differentiated adenocarcinoma	17 (48)	12 (43)	
Poorly differentiated adenocarcinoma	7 (20)	8 (28)	
Other	3 (9)	1 (4)	

Data are expressed as number of patients (% of total group), unless otherwise specified. NS, not significant; AV, anal verge.

gery[18] that are evident in the outcomes of patients undergoing 3-armed laparoscopic or robotic TMEs.[8] Time to flatulence, start time of oral and normal diet, and length of hospital stay were similar in patients who underwent LLAR and RLAR in our study. However, length of stay in the ICU was longer in patients who underwent robotic surgery. This outcome was attributed to the longer duration spent in the deep Trendelenburg position during robotic surgery, which requires longer operative time than that needed for a laparoscopic surgery. Another important finding obtained in this series was that intraoperative blood loss was significantly less with the robotic surgery. We believe that the decreased blood loss with robotic surgery may be a result of the anatomic plans being more clearly identified in robotic surgery, and thus, more precise dissections were performed. No conversion to laparoscopic or open surgery occurred because of bleeding in any patient in the present study.

Anastomotic leakage is the most important postoperative complication in patients with rectal cancer. Many studies comparing open surgery and laparoscopic surgery have obtained similar anastomotic complication rates.[19] Anastomotic leakage rates of 3.5% and 3.6% have been reported in patients with pelvic laparoscopic and robotic surgery, respectively.[20] These values corroborate the results of the patients who underwent both open and laparoscopic LAR. In our series, anastomotic leakage was observed in 4 patients, including 2 who underwent RLAR and 2 who underwent LLAR. All anastomotic leakages resolved with conservative approaches and without the need for reoperation. Studies so far have shown that robotic surgery does not harm the nerve plexus, especially during pelvic dissection, and causes fewer postoperative complications, such as sexual and urinary dysfunctions.[21] Patients who underwent laparoscopic or robotic TME in our series had no such complications.

In a comparison of the long-term outcomes after laparoscopic TME and open TME, similar local recurrence, distant metastasis, and tumor-free survival rates were found.[15] Considering the early period oncologic results of robotic TMEs in rectal cancers, both the laparoscopic and open TME are similar in this regard.[18] However, some researchers have reported that robotic surgery provides better outcomes. Kang et al[22] demonstrated that because of the circumferential margins obtained by robotic surgery, TME qualities are better than those with laparoscopic surgery. Another studies reported that the number of dissected lymph nodes is better with robotic surgery.[23] Indeed, TME quality was better and the number of lymph nodes dissected from the specimens was greater in patients who underwent robotic surgery in the present study, although, this finding was not statistically significant. The probability that robotic surgery yields better oncologic results will be revealed by local recurrence and disease-free survival rates in long-term studies. However, the general opinion today is that the robotic approach is safe and effective and is similar in oncologic results to the laparoscopic approach.[18] An important result obtained in the present study pertains to the more frequent application of robotic surgery for tumors with a lower location. Although we offer both laparoscopic and robotic methods as surgical approaches for patients with a diagnosis of rectal cancer, we suggest that robotic surgery is our preferred choice of treatment. According to the patient's preference, we proceed with one of the methods. It is not inaccurate to say that we recommend robotic surgery a little more strongly for cases with lower rectal tumors.

In conclusion, laparoscopic and robotic TMEs, which were performed in patients with lower rectal cancer, have similar minimally invasive results. A robotic TME has longer operative time and decreased blood loss in comparison to a laparoscopic TME, and although the early oncologic outcomes are in favor of robotic surgery, the results of the 2 methods were statistically comparable in this study. Long-term oncologic follow-up studies are needed to reveal the advantage in oncologic results of robotic surgery for lower rectal cancers.

References:

1. Jacobs M, Verdeja JC, Goldstein HS. Minimally invasive colon resection (laparoscopic colectomy). *Surg Laparosc Endosc.* 1991;1:144–150.

2. Jayne DG, Thorpe HC, Copeland J, Quirke P, Brown JM, Guillou PJ. Five-year follow-up of the Medical Research Council CLASICC trial of laparoscopically assisted versus open surgery for colorectal cancer. *Br J Surg.* 2010;97:1638–1645.

3. Wang CL, Qu G, Xu HW. The short- and long-term outcomes of laparoscopic versus open surgery for colorectal cancer: a meta-analysis. *Int J Colorectal Dis.* 2014;29:309–320.

4. Weber PA, Merola S, Wasielewski A, Ballantyne GH. Telerobotic-assisted laparoscopic right and sigmoid colectomies for benign disease. *Dis Colon Rectum.* 2002;45:1689–1694.

5. Petrucciani N, Sirimarco D, Nigri GR, et al. Robotic right colectomy: a worthwhile procedure? Results of a meta-analysis of trials comparing robotic versus laparoscopic right colectomy. *J Minim Access Surg.* 2015;11:22–28.

6. Trinh BB, Jackson NR, Hauch AT, Hu T, Kandil E. Robotic versus laparoscopic colorectal surgery. *JSLS.* 2014;18:pii: e2014.00187. DOI:10.4293/JSLS.2014.00187.

7. Kwak JM, Kim SH, Kim J, Son DN, Baek SJ, Cho JS. Robotic vs laparoscopic resection of rectal cancer: short-term outcomes of a case-control study. *Dis Colon Rectum.* 2011;54:151–156.

8. Kim CW, Kim CH, Baik SH. Outcomes of robotic-assisted colorectal surgery compared with laparoscopic and open surgery: a systematic review. *J Gastrointest Surg.* 2014;18:816–830.

9. Pai A, Marecik SJ, Park JJ, Melich G, Sulo S, Prasad LM. Oncologic and clinicopathologic outcomes of robot-assisted total mesorectal excision for rectal cancer. *Dis Colon Rectum.* 2015;58:659–667.

10. Bedirli A, Salman B, Yuksel O. Laparoscopic versus open surgery for colorectal cancer: a retrospective analysis of 163 patients in a single institution. *Minim Invasive Surg.* 2014;2014: 530314. DOI: 10.1155/2014/530314.

11. Choi DJ, Kim SH, Lee PJ, Kim J, Woo SU. Single-stage totally robotic dissection for rectal cancer surgery: technique and short-term outcome in 50 consecutive patients. *Dis Colon Rectum.* 2009;52:1824–1830.

12. Guillou PJ, Quirke P, Thorpe H, et al. Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomised controlled trial. *Lancet.* 2005;365:1718–1726.

13. Lujan J, Valero G, Biondo S, Espin E, Parrilla P, Ortiz H. Laparoscopic versus open surgery for rectal cancer: results of a prospective multicentre analysis of 4,970 patients. *Surg Endosc.* 2013;27:295–302.

14. van der Pas MH, Haglind E, Cuesta MA, et al. Colorectal Cancer Laparoscopic or Open Resection II (COLOR II) study group. Laparoscopic versus open surgery for rectal cancer (COLOR II): short-term outcomes of a randomised, phase 3 trial. *Lancet Oncol.* 2013;14:210–218.

15. Jiang JB, Jiang K, Dai Y, et al. Laparoscopic versus open surgery for mid-low rectal cancer: a systematic review and meta-analysis on short- and long-term outcomes. *J Gastrointest Surg.* 2015;19:1497–1512.

16. Kang CY, Halabi WJ, Luo R, Pigazzi A, Nguyen NT, Stamos MJ. Laparoscopic colorectal surgery: a better look into the latest trends. *Arch Surg.* 2012;147:724–731.

17. Baek SJ, Kim CH, Cho MS, et al. Robotic surgery for rectal cancer can overcome difficulties associated with pelvic anatomy. *Surg Endosc.* 2015;29:1419–1424.

18. Xiong B, Ma L, Huang W, Zhao Q, Cheng Y, Liu J. Robotic versus laparoscopic total mesorectal excision for rectal cancer: a meta-analysis of eight studies. *J Gastrointest Surg.* 2015;19:516–526.

19. Krarup PM, Jorgensen LN, Andreasen AH, Harling H, Danish Colorectal Cancer Group. A nationwide study on anastomotic leakage after colonic cancer surgery. *Colorectal Dis.* 2012;14: 661–667.

20. Bhama AR, Obias V, Welch KB, Vandewarker JF, Cleary RK. A comparison of laparoscopic and robotic colorectal surgery outcomes using the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database. *Surg Endosc*. E-pub ahead of print July 1, 2015. DOI 10.1007/s00464-015-4381-9.

21. Kim JY, Kim NK, Lee KY, Hur H, Min BS, Kim JH. A comparative study of voiding and sexual function after total mesorectal excision with autonomic nerve preservation for rectal cancer: laparoscopic versus robotic surgery. *Ann Surg Oncol*. 2012;19:2485–2493.

22. Kang J, Yoon KJ, Min BS, et al. The impact of robotic surgery for mid and low rectal cancer: a case-matched analysis of a 3-arm comparison: open, laparoscopic, and robotic surgery. *Ann Surg*. 2013;257:95–101.

23. D'Annibale A, Pernazza G, Monsellato I, et al. Total mesorectal excision: a comparison of oncological and functional outcomes between robotic and laparoscopic surgery for rectal cancer. *Surg Endosc*. 2013;27:1887–1895.