Robotic Proctectomy for Rectal Cancer: Analysis of 71 Patients from a Single Institution

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ABSTRACT

Background: Despite increasing use of robotic surgery for rectal cancer, few series have been published from the practice of generalizable US surgeons.

Methods: We performed a retrospective chart review for 71 consecutive patients who underwent robotic low anterior resection (LAR) or abdominoperineal resection (APR) for rectal adenocarcinoma between 2010-2014.

Results: We identified 46 LARs (65%) and 25 APRs (35%). Median procedure time was 219 minutes (IQR 184-275) and mean blood loss 164.9 cc (SD 155.9 cc). Radial margin was negative in 70/71 (99%) patients. Total mesorectal excision integrity was complete/near complete in 38/39 (97%) of graded specimens. A mean of 16.8 (SD+/- 8.9) lymph nodes were retrieved. At median follow up of 21.9 months, there were no local recurrences.

Conclusions: Robotic proctectomy for rectal cancer was introduced in to a typical colorectal surgery practice by a single surgeon with a low conversion rate, low complication rate, and satisfactory oncologic outcomes.

INTRODUCTION

The expansion of minimally invasive surgery into rectal cancer has largely been based on case series reports from highly specialized units and extrapolation from the laparoscopic colectomy for cancer literature [1-5]. Concerns about oncologic safety and the technical difficulty of the procedures have slowed wide adoption. The results from two recent randomized controlled studies comparing minimally invasive to open resection for rectal cancer have inspired even greater caution in regard to the use of laparoscopy for rectal cancer [6, 7]. Although robotic procedures were incorporated into the minimally invasive arm of one trial [6], some authors have suggested that the unique technical aspects of the robotic platform may improve upon the short term and technical outcomes observed to be inadequate in these trials [8].

Before advantages of robotic technique for rectal cancer can be demonstrated, consideration of the effect of formal robotic training and learning curves among early cases must be better studied. Traditionally, these studies have been hampered at least in part due to a lack of experience from the practice of generalizable US surgeons where formal robotic training in colorectal surgery is in its infancy.

We sought to critically evaluate the short- and long-term outcomes of robotic rectal cancer resections by a single colorectal surgeon, self-taught after completion of formal training, in an academic institution without a specialized robotics focus.

METHODS

Patients

Following institutional review board approval, retrospective chart review was performed on consecutive patients undergoing robotic proctectomy for rectal adenocarcinoma from 2010-2014 at our institution which include the first robotic cases performed by the author. Patients were excluded for non-cancer indications for proctectomy, incomplete records for review, patients lost to follow up, and operative technique involving initial laparoscopic or open surgery. We analyzed 85 patients with 14 excluded according to the exclusion criteria for a final cohort of 71 patients. Patients who underwent intended robotic proctectomy converted to open procedure were included in the analysis. Patients all underwent appropriate preoperative staging according to the American Joint Committee on Cancer (AJCC) 7th edition, and patients with locally advanced tumors were treated with neoadjuvant chemoradiation in accordance with contemporary practice guidelines at the time of treatment. Patients were classified according to type of operation with sphincter preserving operations categorized as low anterior resection (LAR), which including low anterior resection with ileostomy or colostomy, or anterior resection without proximal diversion, and sphincter sacrificing resection classified as abdominal perineal resection (APR). Robotic proctectomy was performed via a hybrid approach. The splenic flexure was mobilized and the inferior mesenteric artery ligated laparoscopically, after which the robot was docked for the rectal dissection. Perineal dissection for APR was performed in the lithotomy position. Patients who underwent LAR were routinely diverted with loop ileostomy if they had preoperative chemoradiation and the anastomosis was below the peritoneal reflection.

Data on type of procedure performed, preoperative variables including staging and comorbid conditions, operative variables including operative time, conversion to open, lymph nodes retrieved, grade of TME excision, blood loss, and blood transfusion, and postoperative variables including length of stay, 30 day complications, and oncologic outcomes recurrence, disease specific, and overall survival were obtained from the medical record and review of the American College of Surgeons-National Surgical Quality Improvement Program database [9]. Total mesorectal excision (TME) integrity was graded by a pathologist.

Statistical Analysis

Depending on variable distribution, Student T or Mann-Whitney-Wilcoxon test was used for numeric variable comparisons. Chi square test or Fisher's exact test was used for categorical variables whereas appropriate. Multivariate regression analysis was used for statistical control or adjustment to assess the independent association between variables. All tests are two tailed and $p<0.05$ was considered as statistically significant.

RESULTS

Patient demographics

Seventy-one patients who underwent robotic proctectomy for rectal adenocarcinoma were identified and included in our analysis. Forty-six patients (65%) underwent low anterior resection (LAR) and twenty-five patients (35%) underwent abdominal perineal resection (APR). Patient clinicopathologic characteristics are listed in Table 1. Mean age for the cohort was 63.1 years, 69.0 years for the LAR group, and 60.0 for the APR group. Body mass index (BMI) was comparably distributed across the groups. For the full cohort, 45 patients (63%) were male with 27 (59%) in the LAR group and 18 (72%) in the APR group being male. Patient comorbid conditions including smoking history, diabetes mellitus, congestive heart failure, chronic obstructive pulmonary disease (COPD), functional status, preoperative weight loss of greater than 10%, serum albumin, and serum hematocrit are listed in Table 1 with no significant differences existing between the LAR and APR groups.

Surgical and Postoperative Outcomes

The median operative time for robotic proctectomy was 219 minutes with interquartile range (IQR) of 184 minutes to 275 minutes. Median operative time was 237 in the APR group (IQR 182.5-297 minutes) and 208 minutes for the LAR group (IQR 184-261 minutes). Over the study period, a total of 3 operations (4%) were converted to open, which were all patients undergoing LAR and representing 7% of that group. Mean estimated blood loss for the cohort was 164.9 cc (SD 155.9). Following robotic proctectomy, median length of stay was 6 days (IQR 4-8 days) for the entire cohort and 5 (IQR 4-8) and 6 (IQR 4.5-9) days for the LAR and APR groups respectively. The superficial surgical site infection rate was 7% (n=3) in the LAR group and 4% (n=1) in the APR group for an aggregate rate of 6% (n=4). There was one patient (4%) in the APR group that had a deep surgical site infection. Deep organ space infections occurred in 3 patients (7%) in the LAR group and 2 (8%) patients in the APR group. Two patients required return to the operating room, both in the APR group (2/25, 8%), one for debridement of a perineal wound and one for evacuation of a pelvic hematoma. There were no anastomotic leaks in the LAR group. Additionally, in this study, there were no ureteral injuries, urinary tract infections, blood transfusions or mortalities in the 30-day postoperative period.

Tumor and oncologic characteristics

Tumor characteristics, pathologic quality, and oncologic outcomes are shown in Table 3. Tumor location was relatively evenly distributed in the LAR group between the upper, mid, and lower rectum, and all patients who underwent APR had a tumor in the lower rectum. Twenty-nine patients (63%) in the LAR group and 21 patients (84%) in the APR group underwent neoadjuvant chemoradiation for a total rate of 70%. Pretreatment stage and final pathologic stage is shown in Table 3. The circumferential radial margin (CRM) was negative in 70/71 (99%) specimens, 26/26 (100%) LAR and 24/25 (96%) APR. The mean CRM distance was 16.8 mm (SD 8.9 mm) for LAR specimens and 7.6 mm (SD 6.5 mm) for APR specimens. The average number of lymph nodes retrieved was 16.8 (SD 8.9) in LAR specimens and 13.6 (SD 7.1) in APR specimens. Total mesorectal excision (TME) integrity as graded by the pathologist was complete or near complete in 23/23 (100%) of graded LAR specimens and 15/16 (94%) of graded APR specimens for a total rate of 38/39 (97%). The median follow up for the cohort was 17.1 months (Range 0.7 – 53.2 months). There were no documented local recurrences in either surgical group over the study period. Fifty-nine patients (83%) in our study cohort were alive at last follow up with no evidence of disease. Eight patients (11%) were alive with metastatic disease and one patient (1%) died due to cancer. Kaplan-Meier survival estimates are shown for overall survival (Figure 1) and for disease free survival (Figure 2). At five years, disease free survival was 83.1% and overall survival was 94.4%.

DISCUSSION

Despite rapidly expanding robotic technology and increased integration of robotic surgery into colorectal practices throughout the country, there have not been large generalizable studies regarding robotic proctectomy for rectal cancer outside of specialized robotics centers. In this study we report the introduction of robotic proctectomy for rectal cancer into a typical colorectal surgeon's practice at a single university center. Over the first four years of experience robotic proctectomy was performed with a low conversion rate, low complication rate, and satisfactory oncologic outcomes.

The safe dissemination of new techniques, such as robotic proctectomy for rectal cancer, into the generalizable surgeons' practice is an area of important debate [10]. Factors to be considered begin with oncologic safety, but can extend to attitudes by surgeons towards the new technology and techniques, market forces, and how to address the conundrum of safe post-graduate surgical training. In this study we report a low complication rate, however, this should be viewed in light of the limitations of the NSQIP data set for capturing complications, which could result in more frequent adverse events including urinary retention that are not reported here. This case series highlights both the need for further study in the adaption of robotics in rectal cancer surgery and the accomplishment of oncologic safety in the practice of a generalizable colorectal surgeon.

The ability to perform a reproducibly sound oncologic operation is paramount for the introduction of robotic proctectomy into a practice for rectal cancer. We looked at three variables in the specimen to evaluate the adequacy of resection. First, the circumferential radial margin (CRM), which was negative in 70/71 (99%) patients, and mean CRM distance was 9.1 mm. These results are similar to a recent study of robotic proctectomy that reported a 5% rate of positive CRM [2] and other previous studies [1-3, 11-13]. Second, we looked at number of lymph nodes retrieved, which had a mean of 15.7 lymph nodes, which is within the range of 13.0-17.5 previously reported [11, 14, 15]. Finally, the integrity of the total mesorectal excision (TME) grade was available in 39 cases with a complete or near complete grade in 38/39 (97%) patients. These results are comparable to resection characteristics from previous trials, including the CLASICC and COREAN trials, comparing laparoscopic and open proctectomy [6, 16-18].

Recently, all minimally invasive resection for rectal cancer has been questioned based on two randomized trials that both failed to meet non-inferiority criteria for laparoscopic resection versus open resection [6, 7]. The primary endpoints for these trials were defined as successful resection which included CRM, distal margin, and completeness of TME. The long-term consequence of these oncologic outcomes in the neoadjuvant chemoradiation era is incompletely understood and long-term follow up and quantification of recurrence and survival rates will be needed to assess the true oncologic adequacy of laparoscopic proctectomy. Proponents of robotic surgery have argued that its potential advantages, including 3-dimensional optical view, fixed third arm retraction, and wristed instrumentation, might overcome some of the limitations responsible for the inferiority of minimally-invasive proctectomy in these trials. However, the results presented thus far from the ROLARR trial, which randomized patients to laparoscopic versus robotic proctectomy, did not demonstrate any meaningful differences in pathologic or clinical outcomes [19].

Our results must be viewed in light of several limitations and key questions remain for robotic proctectomy for rectal cancer. We presented a single surgeon experience, that while independent and self-taught, did represent an academic practice where the surgeon had extensive laparoscopy colorectal training as part of traditional residency and fellowship training and these factors may limit the generalizability of the experience to non-fellowship trained, private practice surgeons. Additionally, further study is needed to determine the costs associated with robotic proctectomy and this data was not collected in this review.

In conclusion we present a case series review of 71 robotic proctectomies for rectal cancer with a low conversion rate, low complication rate, and satisfactory oncologic outcomes. Our results demonstrate the successful incorporation of robotic proctectomy for rectal cancer into a typical colorectal practice by a single surgeon with good procedural and oncologic outcomes, and highlight the need for feedback and audit of this process as this technology becomes more widely adopted.

DISCLOSURES

Philip M. Spanheimer, John G. Armstrong, Sunyang Fu, Junlin Liao, Scott E. Regenbogen, and John C. Byrn have no conflict o interest or financial ties to disclose.

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Figure 1. Kaplein-Meier plot demonstrating overall survival.

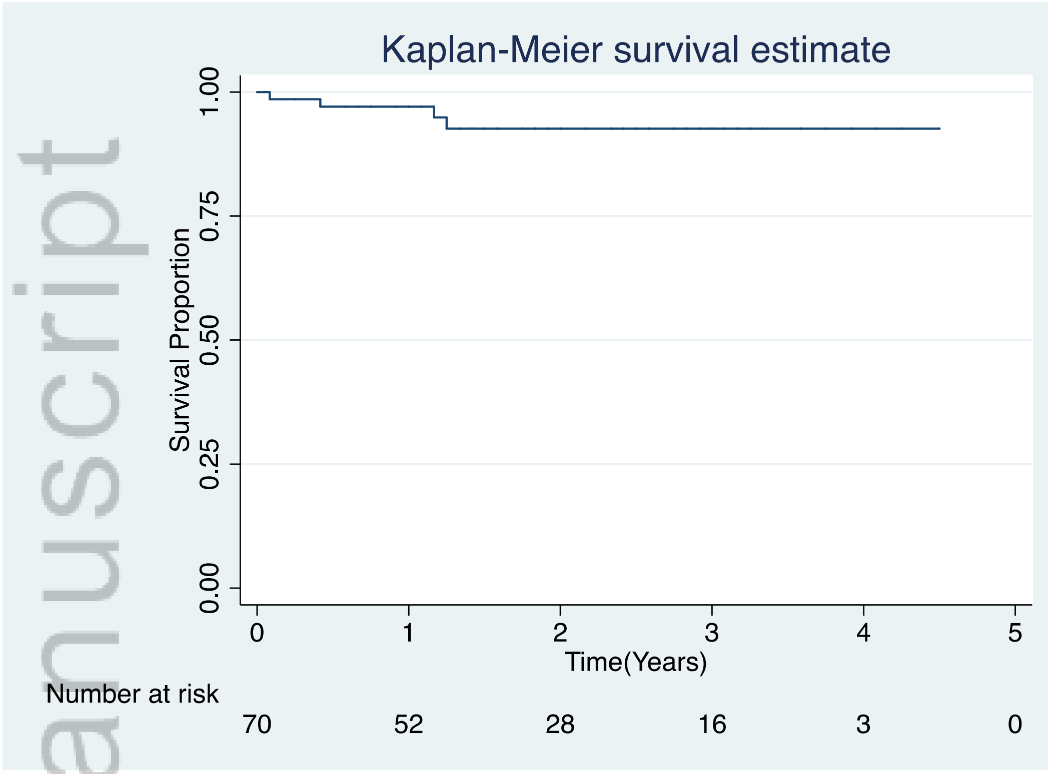

Figure 2. Kaplein-Meier plot demonstrating disease-free survival.

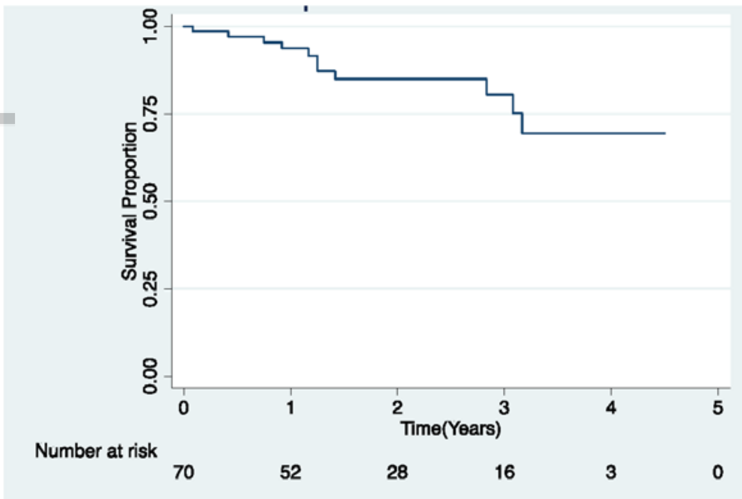

Table 1. Clinicopathologic Characteristics of study population

Characteristic, n (%)	LAR n=46	APR n=25	All N=71
Age in years, mean± SD	60.0±13.1	69.0±12.9	63.1±13.7
Body Mass Index (BMI), mean± SD	26.4±5.0	29.2±8.3	27.4±6.4
≤18.0	2(4%)	2(8%)	4(6%)
18.1-29.9	31(67%)	13(52%)	44(62%)
30.0-34.9	10(22%)	6(24%)	16(23%)
35.0-39.9	3(7%)	1(4%)	4(6%)
≥ 40.0	0(0%)	3(12%)	3(4%)
Male gender	27(59%)	18(72%)	45(63%)
ASA Classification			
1-2	31(67%)	12(48%)	43(60%)
3	13(28%)	13(52%)	26(37%)
4	2(4%)	0(0%)	2(3%)
Patient Smoking History	13(28%)	9(36%)	22(31%)
Diabetes mellitus	5(11%)	4(16%)	9(13%)
Congestive Heart Failure	0(0%)	0(0%)	0(0%)
Chronic Obstructive Pulmonary Disease	4(9%)	1(4%)	5(7%)
Functional status; dependent	1(2%)	1(4%)	2(3%)
Weight loss >10%	4(9%)	2(8%)	6(8%)
Albumin g/dL, mean± SD (n=49)	4.0±0.5	3.9±0.3	4.0±0.5
Hematocrit g/dL, mean± SD	39.5±4.5	39.2±3.8	39.4±4.2

LAR= Low anterior resection with ileostomy or colostomy or anterior resection without proximal diversion; APR= Abdominal Perineal Resection; ASA= American Society of Anesthesiologist

Table 2. Surgical and Postoperative Outcomes

Outcome	LAR n=46	APR n=25	All N=71
Procedure time in minutes (median&IQR)	208(184-261)	237(182.5-297)	219(184-275)
Conversion: n (%)	3(7%)	0(0%)	3(4%)
Estimated Blood loss (cc), Mean± SD	128.5±142.6	237.7±161.2	164.9±155.9
Ureteral injury	0 (0%)	0 (0%)	0 (0%)
Length of stay (LOS) in days (median&IQR)	5(4-8)	6(4.5-9)	6(4-8)
30 day Mortality	0 (0%)	0 (0%)	0 (0%)
UTI	0 (0%)	0 (0%)	0 (0%)
Superficial SSI n(%)	3(7%)	1(4%)	4(6%)
Deep SSI n(%)	0 (0%)	1(4%)	(1%)
Organ space SSI n(%	3(7%)	2(8%)	5(7%)
Transfusion	0 (0%)	0 (0%)	0 (0%)

LAR= Low anterior resection with ileostomy or colostomy or anterior resection without proximal diversion; APR= Abdominal Perineal Resection; UTI=Urinary Tract Infection; SSI-Surgical Site Infection. IQR=Interquartile range

Table 3. Tumor and Oncologic Characteristics

Outcome	LAR n=46	APR n=25	All N=71
Tumor Location			
Upper Rectum (>10cm)	11(24%)	0(0%)	11(15%)
Mid Rectum (6-9cm)	15(33%)	0(0%)	15(21%)
Lower Rectum ($\leq$ 5 cm)	20(43%)	25(100%)	45(63%)
Pretreatment Stage			
I	15(33%)	4(16%)	19(27%)
II	11(24%)	3(12%)	14(20%)
III	20(43%)	18(72%)	38(54%)
IV	0 (0%)	0 (0%)	0 (0%)
Neoadjuvant Chemoradiation	29(63%)	21(84%)	50(70%)
Pathologic stage			
0	2(4%)	4(16%)	6(8%)
I	22(48%)	6(24%)	28(39%)
II	9(20%)	3(12%)	12(17%)
III	13(28%)	12(48%)	25(35%)
IV	0 (0%)	0 (0%)	0 (0%)
CRM – negative n(%)	46(100%)	24(96%)	70(99%)
CRM Distance (mm), Mean$\pm$ SD	10.1±5.5	7.6±6.5	9.1±6.0
Lymph Nodes retrieved, Mean$\pm$ SD	16.8±8.9	13.6±7.1	15.7±8.4
TME integrity (n=39)			
Complete/Near Complete	23(100%)	15(94%)	38(97%)
Incomplete	0(0%)	1(6%)	1(3%)
Follow up (Months, median & IQR)	17.3(11.1-32.7)	14.5(7.9-36.0)	17.3(10.6-34.5)
Alive (NED)	37(80%)	22(88%)	59(83%)
Alive with disease	6(13%)	2(8%)	8(11%)
Death due to cancer	1(2%)	0(0%)	1(1%)
Death due to other cause	2(4%)	1(4%)	3(4%)
Local Recurrence	0(0%)	0(%)	0(0%)

LAR= Low anterior resection with ileostomy or colostomy or anterior resection without proximal diversion; APR= Abdominal Perineal Resection; CRM=Circumferential Radial Margin; TME=Total Mesorectal Excision; NED=No evidence of Disease, IQR=Interquartile range.