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Laparoscopic versus Robotic-assisted Rectal Surgery: A Comparison of Postoperative Outcomes

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Rectal surgery continues to be an area of advancement for minimally invasive techniques. However, there is controversy regarding whether a robotic approach imparts any advantages over established laparoscopic procedures. The aim of this study was to analyze and compare outcomes of laparoscopic and robotic rectal resection operations. A single-institution retrospective review was performed identifying 83 consecutive patients undergoing low rectal resection requiring proximal diversion between 2009 and 2013. The cohort was comprised of 38 laparoscopic and 45 robotic cases. Data were analyzed for postoperative outcomes as well as 30-day morbidity and mortality. Male gender frequency, body mass index, and American Society of Anesthesiologists class were higher in the robotic group (71%, 28.6 kg/m², and 2.6, respectively) compared with the laparoscopic group (42%, 23.7 kg/m², and 2.2, respectively; P<0.01). Length of stay was significantly longer for patients undergoing laparoscopic (7.5 days) compared with robotic procedures (5.7 days, P<0.01). This difference was even greater when comparing patients who underwent a hybrid laparoscopic-assisted open total mesorectal excision (TME) with robotic TME (8.2 vs 5.7 days, respectively, P<0.01). Conversion rate was 7.9 per cent for the laparoscopic group and zero per cent for the robotic (P=0.09). There were no mortalities in either group. A pure laparoscopic or robotic rectal surgery may be associated with a shorter hospital stay compared with a laparoscopic assisted approach.

ROBOTIC SURGICAL TECHNIQUES have come a long way since the robotic stereotactic brain biopsy was developed in 1985.^{1, 2} The first robotic-assisted colorectal surgery was reported in 2001.² Since then the number of robotic colon and rectal operations performed annually has continued to increase. According to data from the Nationwide Inpatient Sample for 2010, 2.78 per cent of all minimally invasive colon and rectal surgeries are now being performed robotically.³ With approximately 128,000 minimally invasive colorectal surgeries being done per year, this amounts to over 3,600 cases annually in the United States.³ These numbers are likely even higher in the present day. Potential benefits for the operating surgeon include better three-dimensional visualization, more precisely controlled instrument movement, elimination of human tremor, 7° of movement mimicking the movements of the human wrist, and superior ergonomics.⁴ All of these factors make it an attractive option for operating in areas of difficult surgical access. The technical challenges of operating in the pelvis are the reason why much of the pioneering work in robotics was propagated by urologists and gynecologists.⁵⁻⁸

Despite a 12-year history, the body of evidence regarding the benefits of robotic-assisted laparoscopic surgery (RALS) over conventional laparoscopic surgery (CLS) in colorectal procedures is limited.^{9–11} Large prospective studies are currently in progress,¹² which should hopefully add depth to the existing body of literature. The aim of this study was to examine a single-center experience with robotic-assisted and laparoscopic rectal surgery and to compare perioperative outcomes between groups.

Materials and Methods

A retrospective review was performed on 83 consecutive patients undergoing low rectal resection with reconstruction and proximal diversion at our institution between June 2009 and August 2013. Procedures included low anterior resection (LAR) and proctocolectomy. RALS was used in 45 of the cases: 29 LARs and 16 proctocolectomies. The daVinci Surgical System (Intuitive technology, Sunnyvale, CA) was the robotic platform used in all robotic-assisted cases. CLS was performed in 38 cases: 18 LARs and 20 proctocolectomies. Preoperative parameters analyzed included age, gender, body mass index (BMI), and American Society of Anesthesiologists (ASA) Physical Status classification. Comorbidities studied were diabetes, hypertension, hypothyroidism, cardiovascular disease, smoking, and steroid use. Operative parameters included conversion to open surgery and estimated blood loss. Complications analyzed included urinary tract infection, ileus, sepsis, cardiac complications, wound infection, intraabdominal abscess, and anastomotic leak. Morbidity and mortality occurring within 30 days postoperatively were recorded. Mean length of stay and 30-day readmission were also reviewed.

All patients in the study underwent an initial laparoscopically performed colon dissection including mobilization of the splenic flexure and the descending colon. The total mesorectal excision (TME) portion of the procedure differed based on whether the patients underwent a robotic or primarily laparoscopic approach. Within the laparoscopic group, 20 patients (52.6%) had an “open” total mesorectal excision, which was performed through a Pfannenstiel incision. The remaining 18 patients (47.4%) underwent an entirely laparoscopic TME. In the robotic group, all patients underwent a robotically performed TME.

Quantitative data were recorded as a mean with standard deviation. Results of the two groups were compared using the independent sample t test for continuous variables and the cross-table Pearson χ^2 test for categorical data. P values < 0.05 were considered statistically significant. GraphPad (GraphPad Software, Inc.) was used for calculations.

Results

Demographic data and preoperative patient characteristics for both groups are shown in Table 1. The mean age overall was 51 years old. There was no statistical difference in age between the two groups (50.1 years in laparoscopic vs 52.4 years in robotic, $P = 0.56$). Gender distribution was 58 per cent male and 42 per cent female overall. The CLS cohort had significantly less male patients (42%) compared with the RALS arm (71%, $P40.01$). The RALS group also had significantly higher mean BMI (28.6 vs 23.7 kg/m², $P < 0.01$) and mean ASA (2.57 vs 2.22, $P < 0.01$) compared

with the CLS.

Malignancy was the most common admission diagnosis, found in 67.5 per cent of patients overall. Significantly more patients undergoing RALS underwent surgery for malignancy (77.8%) compared with patients undergoing CLS (55.3%, $P = 0.04$). Inflammatory bowel disease was the second most common diagnosis overall and was found in significantly more patients undergoing CLS (44.7%) compared with RALS (17.8%, $P = 0.01$). Other diagnoses included familial adenomatous polyposis (4.8%) and diverticulitis (1.2%). There were no significant differences in prevalence of these diagnoses between the two groups. Rates of perioperative chemotherapy (31.6% CLS vs 53.3% RALS, $P = 0.07$) and radiation therapy (23.7% CLS vs 33.3% RALS, $P = 0.47$) were also similar between groups. The majority of the colorectal procedures performed were low anterior resection (56.6%) and proctocolectomy (42.2%).

The majority of the comorbidities analyzed were similar between groups (Table 1). There was a significantly higher rate of preoperative steroid use in the CLS group (39.5% CLS vs 13.3% RALS, $P = 0.01$). Steroid use was noted in patients who were operated on for a diagnosis of inflammatory bowel disease. There were no statistically significant differences between groups for the other parameters analyzed: diabetes, hypertension, hypothyroidism, cardiovascular disease, and smoking.

Postoperative outcomes are seen in Table 2. RALS was associated with a significantly shorter length of hospital stay (5.7 days) compared with CLS procedures (7.5 days, $P = 0.01$). This difference was even more significant on a subset analysis of patients undergoing hybrid laparoscopic-assisted colon mobilization with open TME (8.2 days) versus robotic TME (5.7 days, $P < 0.01$). There was a trend toward lower rates of conversion to open surgery, sepsis, and intraabdominal abscess favoring the robotic cohort; however, P values were not significant. All other outcomes studied showed no statistically significant differences between the groups. A trend toward higher rates of urinary tract infections were noted in the RALS cohort.

TABLE 1. Patient Demographics and Preoperative Characteristics for Laparoscopic versus Robotic-assisted Rectal Surgery

	Laparoscopic (n = 38)	Robotic (n = 45)	P Value
Age (years, SD)	50.1 ± 18.8	52.4 ± 17.2	0.56
Gender (% male)	42.1%	71.1%*	0.01
BMI (kg/m ² , SD)	23.7 ± 4.6	28.6 ± 8.1*	<0.01
Mean ASA (class, SD)	2.2 ± 0.6	2.6 ± 0.6*	<0.01
Preoperative diagnosis			
Malignancy	55.3%	77.8%*	0.04
Inflammatory bowel disease	44.7%	17.8%*	0.01
Familial adenomatous polyposis	5.3%	4.4%	0.99
Diverticulitis	2.6%	0%	0.46
Comorbidities			
Diabetes mellitus	18.4%	6.7%	0.17
Hypertension	31.6%	40.0%	0.5
Hypothyroidism	2.6%	15.6%	0.06
Cardiovascular disease	5.3%	8.9%	0.68
Smoking	18.4%	13.3%	0.56
Steroid use	39.5%	13.3%*	0.01
Perioperative chemotherapy	31.6%	53.3%	0.07
Perioperative radiotherapy	23.7%	33.3%	0.47

* $P \leq 0.05$.

SD, standard deviation; BMI, body mass index; ASA, American Society of Anesthesiologists.

TABLE 2. Operative and Postoperative Outcomes for Laparoscopic versus Robotic-assisted Rectal Surgery

	Laparoscopic (n = 38)	Robotic (n = 45)	P Value
Operative Outcomes			
Conversion to open	7.9%	0%	0.09
Estimated blood loss (mL, SD)	163 ± 115	152 ± 231	0.79
Postoperative outcomes			
Urinary tract infection	0%	11.1%	0.06
Ileus	7.9%	6.7%	0.99
Sepsis	13.2%	2.2%	0.09
Cardiac complications	2.6%	2.2%	0.99
Wound infection	7.9%	2.2%	0.33
Intra-abdominal abscess	23.7%	8.9%	0.08
Anastomotic leak	10.5%	6.7%	0.7
Mean length of stay (days, SD)	7.5 ± 3.6	5.7 ± 3.0*	0.01
30-day readmission	26.3%	20.0%	0.6
30-day morbidity	34.2%	28.9%	0.64
30-day mortality	0%	0%	0.99

* $P \leq 0.05$.

SD, standard deviation.

Discussion

Over the past decade, robotic surgery has evolved to cover a broad range of specialties. Despite this, only 2.78 per cent of all minimally invasive colorectal operations are currently performed using RALS.³ One key issue is the lack of unequivocal evidence either in support of or against the use of RALS.^{9–13} We found that RALS was associated with an almost 2-day reduction in duration of hospital stay when compared with CLS. These findings are in concordance with those of Baik et al.¹⁴ as well as Kim and Kang¹⁵ who reported shorter length of stay in their prospective studies comparing RALS and CLS proctectomy. In contrast, two recent meta-analysis examining outcomes of RALS in rectal cancer found no statistically significant difference in length of stay after proctocolectomy.^{9, 16} In an analysis of 744 robotic-assisted colorectal resections, Keller et al.¹⁷ found a longer length of stay after robotic colon and rectal procedures, but no difference was found in a subset analysis comprised of only rectal operations. Our findings may be the result of the lower conversion rate and lower incidence of some postoperative complications in robotic-assisted cases. Patients undergoing open TME in the CLS group could also have contributed to this difference in results. Although a mini-Pfannenstiel incision is required for specimen extraction, the larger incision for open TME may have resulted in greater postoperative pain and longer recovery. To further examine this possibility, we performed a subset analysis of patients undergoing completely laparoscopic versus robotic TME. We found that the hospital stay was still shorter (6.76 vs 5.69 days) but did not reach significance with a P value of 0.15. This is likely the result of the low power of this subset analysis, because the pure laparoscopic group cohort was comprised of only 17 patients. However, an analysis of patients undergoing hybrid laparoscopic-assisted open TME had a significantly longer length of stay (8.2 days) compared with robotic TME (5.7 days, $P < 0.01$).

The average BMI of patients in the robotic group was 28.6 kg/m² versus 23.7 kg/m² in the laparoscopic group. Robotic assistance may prove to be beneficial in higher risk patients, particularly those who are obese. This is supported by several studies, which have documented the technical difficulties of laparoscopy in the morbidly obese.^{18–20}

Inadequate pneumoperitoneum, problematic maneuvering of instruments, and positioning difficulties are among the most commonly cited challenges.^{19, 21} Despite these difficulties, laparoscopic procedures can be safely performed in obese individuals with good outcomes.^{19, 21, 22} Robotic assistance mitigates some of the technical disadvantages of laparoscopy and may result in improved outcomes for obese patients. However, prospective randomized studies are needed to further examine this trend.

In this study, none of the postoperative outcomes analyzed reached a statistically significant difference between groups. However, our data did show a trend toward decreased rates of conversion to laparotomy, sepsis, and intra-abdominal abscess in robotic-assisted cases. Four recent meta-analyses and systematic reviews showed no significant differences in the rates of sepsis or in the rates of other outcomes studied.^{9–11, 16} Our results could be attributed to patient selection, surgical techniques, or a potentially lower conversion rate within the robotic group. A statistically insignificant trend toward higher rates of urinary tract infections was seen with robotic surgery. A possible explanation for this is the fact that robotic surgery allows for a more extensive and thorough pelvic dissection. Also, patients in the robotic group had higher rates of malignancy, which may have contributed to increased manipulation of pelvic organs and surrounding neurovascular structures, subsequently resulting in increased urinary retention and subsequent urinary tract infections.

There were several limitations to our study. Because the data were collected at a single institution with four surgeons, the selection of the surgical modality used (laparoscopic vs robotic-assisted) was by surgeon preference. This could have resulted in selection bias. However, a surgeon experienced in robotic surgery performed the majority of the robotic-assisted operations. This avoided collection of data during the “learning curve” associated with robotic surgery.²³ The type of rectal operation was also not controlled. Although the difference was not significant, there was a higher number of patients undergoing total proctocolectomy within the laparoscopic group (52.6 vs 33.3%, $P = 0.12$). To further examine the possibility that procedure type may have affected outcomes, a second subset analysis was performed analyzing outcomes within each procedure group—LAR and proctocolectomy. For patients undergoing only LAR, there was a trend toward shorter length of stay in the robotic group (5.44 days RALS vs 7.21 days CLS); however, this did not quite reach significance ($P = 0.11$) as a result of the low power of the analysis with only 10 patients in the laparoscopic LAR group. Finally, oncological outcomes were not analyzed; therefore, the study did not include information regarding lymph node resection, circumferential margin, or distal margin involvement.

Conclusion

This study documents a tertiary care institution’s experience with robotic-assisted and laparoscopic surgery for low rectal dissection. Robotic rectal surgery appears to be advantageous in terms of a reduced duration of hospital stay with comparable 30-day morbidity and mortality. This is despite the fact that the average patient undergoing robotic surgery had a higher BMI and ASA grade. It is difficult to determine whether the shorter length of stay favoring RALS is a reflection of the smaller incision required

for specimen extraction, the lower conversion rate, or a combination of these factors. Large-scale prospective studies are required to further confirm these findings.

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