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Does obesity impact postoperative outcomes following robotic-assisted surgery for rectal cancer?

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Abstract

Introduction Obesity has been identified as a risk factor for both conversion and severe postoperative morbidity in patients undergoing laparoscopic rectal resection. Robotic-assisted surgery (RAS) is proposed to overcome some of the technical limitations associated with laparoscopic surgery for rectal cancer. The aim of our study was to determine if obesity remains a risk factor for severe morbidity in patients undergoing robotic-assisted rectal resection.

Patients This study was a retrospective review of a prospective database. A total of 183 patients undergoing restorative RAS for rectal cancer between 2007 and 2016 were divided into 2 groups: control (BMI <30 kg/m^2; $n=125$) and obese (BMI ≥ 30 kg/m^2; $n=58$). Clinicopathologic data, 30-day postoperative morbidity, and perioperative outcomes were compared between groups. The main outcome was severe postoperative morbidity defined as any complication graded Clavien-Dindo ≥ 3.

Results Control and obese groups had similar clinicopathologic characteristics. Severe complications were observed in 9 (7%) and 4 (7%) patients, respectively ($p>0.99$). Obesity did not impact conversion, anastomotic leak rate, length of stay, or readmission but was significantly associated with increased postoperative morbidity (29 vs. 45%; $p=0.04$) and especially more postoperative ileus (11 vs. 26%; $p=0.01$). Obesity and male gender were the two independent risk factors for post-operative overall morbidity (OR 1.97; 95% CI 1.02–3.94; $p=0.04$ and OR 2.23; 95% CI 1.10–4.76; $p=0.03$, respectively).

Conclusion Obesity did not impact severe morbidity or conversion rate following RAS for rectal cancer but remained a risk factor for overall morbidity and especially postoperative ileus.

Keywords Rectal resection · Rectal cancer · Robotic-assisted surgery · Obesity · Postoperative morbidity · Postoperative ileus

Over the last two decades, minimally invasive techniques have been widely adopted and established as standard procedures in the management of colorectal pathologies [1]. Laparoscopic surgery (LS) for rectal cancer, in comparison to open, has equivalent oncologic outcomes in addition to reduced postoperative pain, length of hospital stay, and morbidity [2–6]. Nonetheless, the benefits of LS remain limited in specific subgroups such as obese patients [7–9]. Due to a variety of underlying comorbidities, in combination with technical difficulties related to an augmented operative field, rectal resection can be very challenging in these patients. Although LS was initially thought to be of high benefit in obese patients, several studies have shown high rates of conversion, anastomotic leak, pelvic abscesses, and severe morbidity in obese patients undergoing laparoscopic colorectal surgery [7–9].

Robotic-assisted surgery (RAS) addresses many of the technical limitations of laparoscopy by offering three-dimensional field of view, articulating instruments with 7 degrees of motion, the ability to retract and control the camera without an assistant, and potentially greater precision of dissection within the narrow confines of the pelvis. Due to these advantages, RAS is being increasingly used in rectal cancer resection [10]. Comparative studies and meta-analyses demonstrate that robotic-assisted surgery achieves similar

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results when compared to laparoscopy in terms of postoperative complications and oncologic outcomes [11–15]. Some authors have reported a trend toward lower conversion rate and lower incidence of genito-urinary complications after robotic-assisted rectal resection [14, 16, 17]. To that end, RAS has been advocated in selected subgroups of patients including obese patients.

In this study, we aimed to determine if an obesity remained associated with severe complications when rectal resection is performed robotically.

Methods

Patients and methods

Patients

A retrospective review of a prospectively maintained database was conducted. All consecutive patients undergoing restorative robotic-assisted proctectomy for primary rectal cancer between January 2007 and August 2016 at Mayo Clinic (Rochester and Jacksonville) were included. Patients who underwent synchronous hepatic resection of liver metastasis, patients operated on for palliative intent, and patients with recurrent rectal cancer were excluded. Patients were categorized into two groups according to the World Health Organization classification of obesity: control (<30 kg/m^2) and obese (≥ 30 kg/m^2). Internal review board approval was obtained. Mayo Clinic was the sole support for this study.

Patients were staged according to the TNM classification system as outlined by the National Comprehensive Cancer Network [18]. Locoregional staging was performed using high-resolution pelvic MRI and/or endorectal ultrasound. Staging for distant disease was by contrast-enhanced computed tomography of the chest, abdomen, and pelvis. Patients with locally advanced rectal tumors (≥ T3) and/or regional lymph nodes (N+) received long-course radiochemotherapy followed by surgery 6–10 weeks later.

Procedure and postoperative care

All robotic-assisted rectal resections were performed by experienced board-certified colorectal surgeons utilizing the Da Vinci® Xi or Si robotic platform (Intuitive Surgical Inc., Sunnyvale, CA, USA).

Rectal cancers involving the external anal sphincter were treated by an abdominoperineal resection and end-colostomy. A tumor-specific excision with resection of the mesorectum 5 cm below the lower border of the tumor was performed for high rectal cancers. A total mesorectal excision was performed for mid and low rectal cancers. Reestablishment of intestinal continuity was performed with either a stapled colorectal or hand-sewn coloanal anastomosis, as appropriate. The indication for diverting ileostomy was left to the surgeon's discretion.

Operations were performed by 9 different colon and rectal surgeons experienced in laparoscopic pelvic surgery (> 50 pelvic laparoscopic operations) prior to beginning their robotic experience. Most robotic cases were performed with assistance from surgical trainees inform our general residency and colon and rectal surgery fellowship programs.

The postoperative care at both institutions followed a standardized enhanced recovery pathway (ERP) [19]. ERP allowed for general oral dietary intake and mobilization on the day of surgery postoperatively. Urinary catheter removal and discontinuation of intravenous fluids were performed on the first postoperative day. In cases of urinary retention intermittent catheterization was utilized until the return of spontaneous voiding. Patients were discharged when postoperative pain was controlled with oral medication, appropriate bowel movement or ostomy output occurred, and diet was tolerated.

Data collection

Preoperative characteristics, perioperative, and postoperative outcomes were retrospectively reviewed. Comorbidity severity was scored according to the American Society of Anesthesiology (ASA) score. Operative time was defined as time between skin incision and closure. Postoperative morbidity was defined as any complication occurring during the first 30 postoperative days. Complications were rated using the Dindo-Clavien classification [20]. Severe complications were defined as complications with a Dindo score ≥ 3. Surgical complications included anastomotic leak, reoperation, postoperative hemorrhage, anemia requiring transfusion, prolonged ileus, wound infection or disunion, and urinary complications. Medical morbidity included cardiopulmonary complications and renal failure. Anastomotic leak was defined as any feculent or purulent drain output or contrast extravasation on CT-scan. Intra-abdominal collection without any radiologic evidence of anastomotic leak were not considered as leaks. Urinary retention was defined as persistent urinary catheter at dismissal. Prolonged ileus was defined as the absence of bowel function after 5 postoperative days and/or insertion of nasogastric tube.

Statistical analysis

Statistical analysis was performed using JMP® software (version 10.0.0; JMP®, SAS Institute Inc., Cary, NC). Data were expressed as mean values ± standard deviation. Univariate analysis was performed using a Student's *t* test or a Mann Whitney *U* test, as appropriate, for continuous variables, and a Fischer's exact test or a χ^2 test, as appropriate, for categorical variables. To compare continuous variables between three groups, a one-way ANOVA was used. The variables found relevant in the univariate analysis ($p < 0.10$) were included into a multivariate logistic regression model. A value of $p < 0.05$ was considered statistically significant.

Results

Patients

Between January 2007 and August 2016, a total of 183 patients (57 females) underwent RAS for rectal cancer. Mean age at surgery was 58 ± 12 years. Patients had a mean BMI of 28 ± 5 kg/m^2. Fifty-eight (15%) patients were included in the control group (BMI < 30 kg/m^2) and 125 (85%) in the obese group (BMI ≥ 30 kg/m^2). Thirteen (7%) patients presented with severe obesity (BMI ≥ 35 kg/m^2) including 6 (3%) with morbid obesity (BMI ≥ 40 kg/m^2). Neoadjuvant radio-chemotherapy was administered in 106 (58%) patients for locally advanced cancer ($n = 32$), regional mesorectal lymph node involvement ($n = 11$), or both ($n = 63$). Coloanal and colorectal anastomosis were performed in 96 (52%) and 87 (48%), respectively. Characteristics of patients are presented in Table 1.

The control and obese cohorts had similar characteristics (Table 1).

Perioperative outcomes

Operative time significantly increased with BMI, from 323 ± 112 min to 363 ± 108 min in the control and obese groups, respectively ($p = 0.02$) (Table 2). The conversion rate was not significantly different between groups. Short-term (30-day) morbidity was noted in 64 (35%) patients, including 13 (7%) patients with severe complications. One patient died from hemorrhagic shock in the early postoperative period. Reoperation was required in 9 (3%) patients due to anastomotic leak ($n = 7$), small bowel obstruction ($n = 2$), and postoperative hemorrhage ($n = 1$). Percutaneous drainage for pelvic collection or leak was performed in 4 (2%) patients. Pelvic collection without any radiologic evidence for anastomotic leak were observed in 3 (2%) patients including suspicion of small abscess treated with antibiotics ($n = 2$) and sterile hematoma confirmed by percutaneous drainage ($n = 1$). Twenty-two (12%) patients were readmitted during the first postoperative month, including 20 patients with ileostomy and 2 without any diversion. Postoperative complications are presented in Table 2.

Table 1 Clinicopathological characteristics

Patient groups	Control BMI < 30 ($n = 125$)	Obese BMI ≥ 30 ($n = 58$)	Total ($n = 183$)	p
Gender (female)	39 (31)	18 (31)	57 (31)	0.98
Mean age (years)†	58 ± 13	59 ± 10	58 ± 12	0.48
ASA score ≥ 3	37 (30)	18 (31)	55 (30)	0.84
History of abdominal surgery	27 (22)	13 (22)	40 (22)	0.90
Tumor location				0.66
Upper rectum	30 (24)	12 (21)	48 (26)	
Mid-rectum	37 (30)	21 (36)	55 (30)	
Lower rectum	58 (46)	25 (43)	80 (44)	
Clinical tumor stage				> 0.99
T1-2	44 (35)	20 (35)	64 (35)	
T3	75 (60)	36 (62)	111 (61)	
T4	6 (5)	2 (3)	8 (4)	
Neoadjuvant RT	72 (58)	34 (59)	106 (58)	0.99
Temporary diversion	104 (83)	49 (84)	153 (84)	0.83
Coloanal or low-colorectal anastomosis	99 (79)	47 (81)	146 (80)	0.77
Pathology tumor stage				0.17
0–1	57 (46)	33 (57)	90 (49)	
2	28 (22)	5 (9)	33 (18)	
3	37 (30)	18 (31)	55 (30)	
4	3 (2)	2 (3)	5 (3)	

Each values express as n(%) except † expressed as mean ± standard deviation

Table 2 Perioperative outcome

	Control BMI < 30 kg/m^2 (n = 125)	Obese BMI ≥ 30 kg/m^2 (n = 58)	Total (n = 183)	p
Conversion rate	2 (2)	1 (2)	3 (2)	> 0.99
Mean operative time (min)†	323 ± 112	363 ± 108	335 ± 112	0.02*
Severe complications	9 (7)	4 (7)	13 (7)	> 0.99
Overall complications	37 (29)	26 (45)	64 (35)	0.04*
Acute urinary retention	14 (11)	10 (17)	24 (13)	0.86
Hemorrhage	0	1 (2)	1 (1)	0.32
Pelvic collection	1 (1)	2 (3)	3 (2)	0.24
Anastomotic leak	6 (5)	4 (7)	10 (5)	0.73
Wound infection	4 (3)	2 (3)	6 (3)	> 0.99
Ileus	14 (11)	15 (26)	29 (16)	0.01*
Cardiopulmonary complication	1 (1)	2 (3)	3 (2)	0.24
Vein thrombosis	3 (2)	0	3 (2)	0.55
Length of hospital stay (days)†	4.3 ± 3.8	5.1 ± 3.3	4.5 ± 3.6	0.12
Readmission	15 (12)	7 (12)	22 (12)	0.99
Lymph nodes resected†	27 ± 14	26 ± 11	26 ± 13	0.58
Positive resection margins				
Circumferential margin	2 (2)	1 (2)	3 (2)	> 0.99
Distal margin	0	0	0	

Each values express as n (%) except † expressed as mean ± standard deviation

*Statistical significance

Impact of obesity on postoperative morbidity

Obesity was not associated with increased rates of severe postoperative morbidity following RAS for rectal cancer (7 vs. 7%; $p > 0.99$). Overall morbidity was significantly higher in obese patients (45 vs. 29%; $p = 0.04$) (Table 2). In severe obese patients (BMI ≥ 35 kg/m^2; $n = 13$), overall and severe morbidity rates were 38 and 0%, respectively. In morbid obese patients (BMI ≥ 40 kg/m^2; $n = 6$), overall and severe morbidity rates were 50 and 0%. Obese patients experienced higher rates of postoperative ileus (11 and 26% ; $p < 0.01$). Obesity was not significantly associated with increased rate of anastomotic leak (5 vs. 7% in control and obese groups, respectively). Length of stay and readmission rates were not affected by obesity.

In univariate analysis, two factors were significantly associated with general postoperative morbidity, male gender, and increased BMI (Table 3). Age, ASA score, history of abdominal surgery, metastatic disease, neoadjuvant chemoradiation, surgical procedure, conversion rate, operative time, and pathology were not associated with postoperative morbidity. Multivariate analysis confirmed that obesity and male gender were the two independent risk factors for postoperative complications following robotic-assisted rectal resection (Table 3).

Discussion

In our study, obesity was not associated with increased risk for major complications following RAS for rectal cancer. In comparison to normal weight, obese patients had similar rates of severe complications, hospital length of stay, and readmission. Moreover, obesity was not associated with a higher risk of anastomotic leak. Our cohort confirms the results of other recent studies comparing severe morbidity following robotic colorectal surgical outcomes in obese and non-obese patients [21–23]. In a recent cohort of 283 patients undergoing restorative RAS for rectal cancer, Baukloh et al., reported similar rates of severe morbidity and anastomotic leak between obese and non-obese patients [24].

Until recently, the impact of obesity on minor complications has been poorly investigated in patients operated on with RAS for rectal cancer. Small retrospective robotic colorectal studies have not demonstrated any difference between obese and non-obese patients in terms of overall morbidity [21–23]. Our study is the first to evaluate the impact of obesity on overall morbidity in a large cohort of patients operated on with RAS for rectal cancer. We have shown that obesity remained an independent risk factor for overall postoperative morbidity following robotic restorative proctectomy, largely driven by a higher rate of postoperative ileus.

Table 3 Univariate and multivariate analyses of predictive factors for postoperative morbidity

Characteristics	Univariate analysis			Multivariate analysis		
	No morbidity $n=120$	Morbidity $n=63$	p	OR	95% CI	p
Gender (male)	76 (63)	50 (79)	0.03*	2.23	1.10–4.76	0.03*
Age (years)†	57 ± 11	59 ± 14	0.35			
ASA score ≥ 3	32 (27)	23 (36)	0.17			
Obesity (BMI ≥ 30 kg/m^2)	32 (27)	26 (41)	0.04*	1.97	1.02–3.84	0.04*
Tumor location			0.37			
Upper rectum	30 (25)	12 (19)				
Mid-rectum	34 (28)	24 (38)				
Lower rectum	56 (47)	27 (43)				
Neoadjuvant radiation	66 (55)	40 (63)	0.27			
Previous abdominal surgery	28 (23)	12 (19)	0.50			
Surgical procedure			0.50			
Coloanal or low-colorectal anastomosis	94 (78)	52 (82)				
Colorectal anastomosis	26 (22)	11 (18)				
Temporary diversion	96 (80)	57 (90)	0.07	2.32	0.93–6.69	0.09
Conversion	2 (2)	1 (1)	> 0.99			
Operative time, min†	327 ± 113	352 ± 107	0.13			
Pathology tumor stage			0.19			
(y)pT0-2	70 (58)	43 (68)				
(y)pT3-4	50 (42)	20 (32)				
Metastatic cancer	3 (2)	2 (3)	> 0.99			
Positive circumferential margin	3 (2)	0	0.55			

Each values express as *n* (%) except † expressed as mean ± standard deviation

*Statistical significance

Increased risk of postoperative ileus with obesity has been reported in several cohorts of patients undergoing both laparoscopic and open rectal resection [25, 26]. Heus et al. recently demonstrated that visceral obesity determined on computed tomography-scan was a risk factor for postoperative complications following laparoscopic or open rectal resection [25]. Similarly in our study, obese patients had a twofold increased risk of experiencing a postoperative ileus as compared to non-obese patients. The reasons for increased rates of postoperative ileus in obese patients remain largely unknown. Only a few studies have demonstrated an association between obesity and gastrointestinal dysmotility that could be explained by high-fat diet-induced alterations in neuromuscular transmission and smooth-muscle excitability [27, 28]. Given the high rate of postoperative ileus in obese patients, further studies focusing on the mechanisms involved would be of high interest to determine adequate preventive measures.

Our results demonstrate that obese and non-obese patients operated on with RAS for rectal cancer had similar rates of anastomotic leak and conversion. Previous series suggest that obese patients operated on with conventional laparoscopy experience more anastomotic leaks than non-obese patients following colorectal surgery [7–9]. Denost and colleagues also noted a conversion rate of 5% in normal weight patients compared to 32% in obese patients undergoing conventional laparoscopic rectal resection [29]. In our study, the conversion rate during RAS for rectal cancer was similar in obese and non-obese patients, and less than 5%. According to these results, we can speculate that RAS may help to prevent some of the poor outcomes observed in obese patients with conventional laparoscopy. Data obtained recently from retrospective comparative studies reported similar conversion and severe morbidity rates between laparoscopic and RAS for rectal cancer in obese patients [30, 31]. However, these studies which are based on small cohorts of patients could have underestimated the benefit of RAS in obese patients. Larger comparative studies are required to determine if RAS confers better results than laparoscopic surgery in obese patients undergoing rectal resection.

Limitations to our study include its retrospective design and the small size of the groups that could have resulted in an underestimation of postoperative morbidity and readmission rates. Likewise, our definition of obesity was based on the World Health Organization classification of BMI whereby other studies have demonstrated that measuring visceral obesity is more predictive of postoperative outcomes following abdominal surgery [32, 33].

Conclusion

Obesity remains an independent risk factor for overall postoperative morbidity following robotic restorative proctectomy. However, obese patients experience similar severe morbidity and conversion rates than non-obese patients when proctectomy is performed with RAS.

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Compliance with ethical standards

Disclosures Drs Emilie Duchalais, Nikolaos Machairas, Scott R. Kelley, Ron G. Landman, Amit Merchea, Dorin T. Colibaseanu, Kellie L. Mathis, Eric J. Dozois, and David W. Larson have no conflicts of interest or financial ties to disclose.

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