Laparoscopic Colorectal Resection in the Obese Patient

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ABSTRACT

Laparoscopic colorectal surgery is an accepted alternative to conventional open resection in the surgical approach of both benign and malignant diseases of the colon and rectum. Well-described benefits of laparoscopic surgery include accelerated recovery of bowel function, decreased post-operative pain and shorter hospital stay; these advantages could be particularly beneficial to high-risk patient groups, such as obese patients. At present, data regarding the application of the laparoscopic approach to colorectal resection in the obese is equivocal. We evaluate the available evidence to support laparoscopic colorectal resection in the obese patient population.

KEYWORDS: Obesity, laparoscopy, colectomy, colorectal surgery

Objectives: On completion of this article, the reader should be able to summarize the advantages and disadvantages of laparoscopic colorectal resections in obese patients.

Obesity has become a global epidemic of major public health concern; at present ~35% of U.S. adults are obese (body mass index (BMI) $\geq$30 kg/m^2) with an annual increase in the proportion categorized as morbidly-obese (BMI >40) or super-obese (BMI >50).[1] Obesity contributes significantly to global morbidity, mortality and socioeconomic burden; the US Centers for Disease Control estimates that there are almost 300,000 premature deaths per annum in the US consequent to this disease, which accounts for more deaths than lung, breast, colon, and prostate cancers combined.[2] A plethora of comorbidities are associated with obesity including insulin resistance, diabetes mellitus, hypertension, cardiovascular disease, sleep apnea, dyslipidemia, and various malignancies.[3–5] These patients present in a physiological state of disarray, compounded by pro-inflammatory and pro-thrombotic tendencies. Such phenomena present significant challenges when these patients present for surgical management of any condition.[6] Laparoscopic colectomy is associated with short-term benefits including quicker resumption of gastrointestinal function and diet, decreased postoperative opioid use, shorter hospital stay and reduced incidence of wound infection.[7–11] In addition, level 1 data exists to support equivalent oncological outcomes between open and laparoscopic resection for colon cancer.[11–13] Many data have suggested that obesity and its related pro-inflammatory and metabolic derangements may be a risk factor for the development of colorectal cancer and negatively impact long-term outcomes following potentially curative resection. In male obese subjects the risk of colorectal cancer increases by 80%.[14] Similarly, obesity increases the risk of colon cancer and high-risk adenomas by almost 2 fold with insulin and insulin-like growth factor postulated as being important mediators in the oncogenic process.[15,16] Data

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on long-term survival after colorectal cancer surgery is equivocal. Evidence exists to suggest that obese subjects are less likely to have sphincter-preserving surgery, and might have a higher rate of local recurrence and death from colonic and rectal cancer.[17–19] In contrast, several studies have shown equivalent long-term, disease specific survival in obese patients.[20,21] The global increasing prevalence of obesity means that surgeons are increasingly faced with the challenge of finding the optimal operative approach to a complex, high-risk group of patients. This review focuses on the feasibility of laparoscopic colorectal resection in obese subjects.

METHODS

We performed a Medline search from 1990 to the present using Medical Subjects Headings (MeSH) terms obesity, laparoscopic resection, colorectal cancer, BMI, complications, outcomes, morbidity and mortality. A manual search of articles relevant to this study was also conducted. Full text articles and abstracts were utilized without language restriction. Important research developments and data available from high volume institutions form the basis of this review.

RESULTS

Outcomes of Laparoscopic Colorectal Resection in Obese Subjects

Obese patients often have comorbidities and are considered to be a subgroup of individuals at high perioperative risks. It is therefore very important to analyze the results of perioperative morbidity in obese patients treated with laparoscopic surgery when compared with similar results from non-obese individuals. Overall morbidity in the laparoscopic arm of major randomized controlled trials (RCTs) comparing laparoscopic versus open colorectal resection ranges from 12–37.8%. On the other hand, reported overall morbidity after laparoscopic colorectal surgery in obese patients ranges from 9–33%, with one study reporting 78% morbidity in a small cohort of patients as reported in Table 1. An accurate comparison of these raw percentages among obese and non-obese patients from different studies remains prohibitive. In fact, the definitions of morbidity are extremely variable and a degree of selection bias for patients individually treated with laparoscopic surgery, even if enrolled into a RCT evaluating laparoscopic surgery is inevitable. Having said that, many data have supported the use of a minimally invasive approach to surgery in obese patients, and evidence exists to support outcomes similar to those achieved in laparoscopic surgery for non-obese counterparts. The following review discusses the practical challenges surgeons face when approaching laparoscopic colorectal surgery in obese patients and synopsizes the most current data on obese patients on several relevant outcomes using as reference points the results of RCTs comparing laparoscopic and open colectomy.

Practical Tips for Laparoscopic Colorectal Surgery in the Obese

Most surgeons would agree that a colorectal resection is more difficult in obese subjects, and this is particularly the case when obese patients are approached laparoscopically. Ideally, a minimally invasive approach should only be considered in the obese when the operating surgeon has significant experience in laparoscopic colorectal surgery. This is especially true for procedures involving dissection in the deep pelvis such as ultra-low anterior resection and ileal pouch-anal anastomosis. Having said that, the prevalence of obesity makes it almost inevitable that in our practice we will encounter obese patients who are willing to undergo and often request laparoscopic surgery.

First, the increased risk of conversion should be discussed with the patient preoperatively to appropriately calibrate expectations. In general, an obese male patient may prove more difficult than an obese female patient due to differences in intra-abdominal fat distribution. In fact, it is not uncommon among obese females to note relatively normal intra-abdominal fat distribution associated with abundant fat deposition in the subcutaneous abdominal pannus, hips and legs. Obese individuals are predisposed to increased risk of intraoperative nerve injuries and patient positioning on the operating bed should be particularly accurate in this population to minimize the incidence of nerve injury from compression or traction.

Since exposure can be more challenging in obese patients, it is desirable to have experienced surgeons as assistants for both retraction and camera handling. In this respect a 30-degree camera may be particularly helpful to facilitate laparoscopic exposure. In addition, the use of 10-mm instruments such as the 10-mm laparoscopic Babcock grasper can allow greater leverage for retraction. In some cases it might be desirable to use a liver retractor especially for exposure of the rectum for deep pelvic dissection. In addition, the exact port site location for both the camera and the operating instruments should be decided by taking into consideration the size of the abdomen to ensure that both the camera and the laparoscopic instruments can reach the deep pelvis or the flexures as needed. In this respect, positioning the instruments on the patient's abdomen before actually making the port site incisions can help estimate appropriate port site positioning. Similarly, the location of a hand-assisted device should also be carefully decided, since it may be technically difficult in some patients to reach the splenic flexure through a Pfannenstiel incision. During the operation, the surgeon should

Table 1 Obese versus Non-Obese Patients Undergoing Laparoscopic Surgery

Author	Year	N Obese/ Non-Obese	Type of Operation	OR Time (min) Obese/ Non-Obese	EBL (mls)	Conversion Rate (%) Obese/ Non-Obese	Overall Morbidity	Anastomotic Leak (%)	Wound Infection	Restoration Bowel Function (days)	LOS (days)	CP/TE Complications
Teuch	2001	21	Sigmoid Colectomy	247	NA	19	17.2	4.7	14.2	NA	9.8	NA
		56		187		17.2	19	3.4	6.9		8.3	
Pikarsky	2002	31	Segmental Colectomy (right, left, trans, sigmoid)	177.1 ± 70	204.8 ± 124.1	39	78*	0	12.9	¶ Higher ileus rate in obese	9.5	12.9
		131	Ant. resection	170.8 ± 64.1	186.2 ± 179.4	13.5*	24	1.5	3.1*		6.9*	2.3
Senagore	2003	59	Segmental Colectomy.	109 ± 36	NA	23.7	22*	5.1	NS	Equivalent Ileus rate†	4 ± 4	0
		201	SB Resection	94 ± 39*		10.9*	13	1.2*			4 ± 3	5
Schwandner	2004	95	Segmental Colectomy	210(71)	NS	7.3	12.8	NS	NS	4.5	13.4	NA
		494	ICR Ant. Resection	195(76)		9.5	6.6			4.1	12.5	
Dostalik	2005	80	Segmental/Ant. Resection/APR	151 ± 50	NA	Excluded from analysis	33	NA	NA	Median 4	14 ± 11	NA
		355		141 ± 55			24			Median 4	12 ± 9	
Leroy	2005	23	Left colectomy	160 ± 59	NA	0	9	0	NA	2.2	7 ± 2.5	1
		88		184 ± 62		6	9	3.5		2.1	9.5 ± 7	0
Scheidbach	2008	1019	Segmental/Ant. Resection/ICR	191.1	NA	13.1	20.7	3.6	5.6	3.7	11/13§	2.55
		4834	Hartmann's/Reversal	166.9*		5.5*	20.2	2.25	7.2	3.7	11	2.35
Kamoun	2009	62	Segmental/TAC/Ant. Resection/Rectopexy	268 ± 74	NA	32	31		15	NS	11 ± 10	NA
		118		232 ± 59*		14*	19		3		9 ± 8	
Park‡	2010	645	Segmental/Hartmann's/ LAR/APR/TAC	258	225.2	14.8	NS	0	1	0	12.1	NA
		312		201*	145.5*	2.6*		3	6	26	9.5*	
Khoury	2011	436	Segmental/TAC/TPC,EI/ TPC,IPAA/LAR	171.5(74.7)	224.9(240.3)	13.3	32.1*	3.4	10.6	5.3	5.9	5.27
		436	APR/SB Resection	157.3(71.7)*	164.6(150.9)*	7.1*	25.7	2.1	4.8*	5	5.6	3.66

§Comparison of three separate groups. Group 1, non-obese; Group 2, obese Grade I; Group 3, obese Grade II/III. Significance in LOS between those in obese II/III category as compared with non-obese.
¶Ileus rate of 32.3%in obese versus 7.6% in non-obese, $p < 0.05$.
†Ileus rate of 5% in obese versus 2% in non-obese; NS, not significant.
CP/TE complications, cardiopulmonary and thromboembolic complications.
*$p < 0.05$; NS, not significant.

have a low threshold to insert additional trocars to facilitate exposure.

Failure to make meaningful progress in the conduct of the operation should prompt the surgeon to consider conversion. The benefits of a laparoscopic procedure may be lost if the patient has a prolonged operation. In fact, obesity further complicates the relative difficulty deriving from unusual anatomy or inflammatory reactions. For example, a large phlegmon or inflamed and redundant colon in an already significantly obese patient might make it impossible to complete the laparoscopic procedure in a reasonable time, if at all. In this case it is very important to develop the ability to recognize the situation and promptly convert instead of embarking on a long surgical procedure only to convert later in the case.

Intracorporeal vessel ligation is preferable in obese patients; extracorporeal ligation can be remarkably difficult as the thickness of the abdominal pannus can make exteriorization of the specimen difficult. Furthermore, obese patients often carry foreshortened mesentery and mesocolon, which are at increased risk of tearing at the time of bowel extraction. In this regard, the use of energy delivery devices in this patient population can therefore be particularly valuable. On the other hand, the omentum can be particularly bulky and become an obstacle to specimen extraction. It is therefore important to assess the position of the omentum before extraction and complete omental dissection from the colon as necessary.

Lastly, specimens are significantly larger due to mesenteric obesity, obese epiploic appendages, and fatty omentum, making specimen extraction particularly challenging. Surgeons should have a low threshold to enlarge the extraction site wound to facilitate this aspect of the case. When all is said and done, the incision even after extension will remain relatively small in the background of a large abdominal pannus.

OPERATING TIME

The literature is consistent in reporting prolonged operative time for laparoscopic colorectal resection in the obese population. However, in 2005 Delaney et al performed a case-matched comparative study from our institution examining the feasibility of open versus laparoscopic colectomy in obese subjects. Results did not demonstrate any difference in operating times between procedures performed by conventional, open surgery versus minimally invasive approach (median operating time 110 minutes versus 100 minutes, respectively), with a trend toward shorter operations in the laparoscopic group.[22] These results might depend on appropriate patient selection and surgical expertise but also rapid decision to convert and are in contrast with the results from randomized trials in colon carcinoma uniformly indicating longer operating times for the laparoscopic arms. With respect to comparison between obese and non-obese patients after laparoscopic surgery, early reports from the Cleveland Clinic experience with laparoscopic colectomy found that operating time was significantly longer in obese subjects compared with normal weight patients (109 versus 94 minutes, $p < 0.05$).[23] Since then, we have performed almost 500 laparoscopic intestinal resections in obese patients which confirm that operations in obese patients take longer to complete (172 versus 157 minutes, $p = 0.017$).[24] The German Laparoscopic Colorectal Surgery Study Group (LCSSG), which reports on the largest experience in the literature, found that mean operating time increases proportionally with BMI (167 minutes for non-obese, 182 minutes for obese with BMI <34.9 and 191 minutes for BMI $\geq$35, $p < 0.001$).[25] Kamoun et al, in reporting their outcomes in a matched series of 62 obese and 118 non-obese patients, found similar outcomes; time to completion of operation was longer in the obese group (268 minutes versus 232 minutes, $p < 0.001$).[26] An Asian study examining the validity of a laparoscopic approach in overweight patients also found a relationship between increasing BMI and longer mean operating times (258 for obese versus 201 and 215 minutes for normal weight and overweight patients, respectively, $p = 0.001$).[27] With regard to specific surgical procedures, Teusch and colleagues uncovered a trend in longer operations with increasing weight. In their study of 77 patients undergoing laparoscopic sigmoidectomy for recurrent diverticulitis the operating time was significantly longer for those with BMI >30 when compared with BMI<25 (247 versus 187 minutes, $p = 0.003$).[28] However, some recent data exists which contradicts the relationship beween increased operating times and obesity; a French study focused on laparoscopic left colectomy for both benign and malignant disease did not show a difference in operating time between the two groups, irrespective of the underlying etiology.[29] Schwandner et al did not find a statistically significant difference in operating times between obese and non-obese (mean 210 minutes versus 195 minutes), although there was a trend toward longer operative time in the obese group.[30] Differences in absolute operative times and between obese and non- obese individuals reported in different series might vary based on individual surgeons and selection criteria for laparoscopic procedures. However, most of the evidence indicates that a surgeon should expect that the same laparoscopic surgical procedure in the obese patient requires longer operative time than in a patient of normal weight.

ESTIMATED BLOOD LOSS

Data from the major RCT's investigating the advantages of laparoscopic over open colorectal cancer resection have not clearly demonstrated that the laparoscopic approach is associated with decreased perioperative blood loss (Table 2). In particular, the COLOR trial described a lower estimated blood loss (EBL) in the laparoscopic group compared with conventional open surgery (100 versus 175 minutes, $p < 0.001$) and the MRC CLASICC trial did not identify any difference in postoperative transfusion requirements between open and laparoscopic groups (15% versus 20%, respectively; $p = 0{\cdot}11$). Critical appraisal of available literature does not evince any strong data to support the contention that obese patients require more blood transfusion than non-obese subjects. The LCSSG study found no differences in intra-operative or post-operative bleeding between the two groups. While the authors did not specifically report on transfusion requirements, obese subjects who had post-operative bleeding were not significantly more likely to require reoperation for bleeding. Similarly, Schwandner and colleagues did not observe either an increased incidence of reoperation for bleeding in obese patients among 589 consecutive patients treated with laparoscopic colorectal surgery (3.5% obese versus 3.3% non-obese, $p > 0.05$) or an increased need for blood transfusion in obese patients (1.8% transfusion rate for obese versus 2.5% for non-obese patients, $p > 0.05$). An additional European study limited to the evaluation of patients undergoing laparoscopic left hemicolectomy also indicated that obesity is not predictive of increased EBL during laparoscopic resection. Furthermore, the Cleveland Clinic Florida group, in their analysis of laparoscopic resections in their patient population, demonstrated a trend toward increased mean intra-operative blood loss in obese patients (205 mls versus 186 mls in non-obese) but this finding did not reach statistical significance and the difference in EBL would be of dubious clinical significance.[31] Our own recently published experience with 872 patients showed equivalent need for blood transfusion between the two groups (3.4% non-obese versus 3.2% for obese patients, $p = 0.999$). The perioperative transfusion rate in obese patients treated with laparoscopic intestinal resection remains in the single digit and is consistently comparable among various series to the transfusion rate for laparoscopic intestinal resection in non- obese patients. Estimated blood loss should therefore not be a concern preventing the use of the laparoscopic approach in this patient population.

CONVERSION RATES

There is not a uniformly accepted definition of conversion in patients undergoing laparoscopic intestinal resection. On appraising the data to hand, it would appear that a conversion can be alternatively defined as any unplanned laparotomy through a midline or Pfannenstiel incision, or an incision >6 cm or a planned incision done sooner than expected.[32,33] Most surgeons would agree that extension of the wound beyond the length of incision required to exteriorize the specimen constitutes a conversion. Most observers would consider a 5–6 cm incision as acceptable for specimen extraction. However, no consensus currently exists and the required length for an extraction site in obese patients might exceed this size. In general, reported conversion rates from prospective randomized trials analyzing laparoscopic colectomy range between 11% and 29%.[7–11]

Table 2 Comparison of Laparoscopic versus Open Colorectal Resection from the Major Prospective Randomized Controlled Trials

Study	Year	No. of Patients	EBL (mls)	Operating Time (mins)	Conversion Rate (%)	Time to First Flatus or BM	Time to Resumption of Diet (days)	Overall Morbidity (%)	Anastomotic Leak (%)	Wound Infection (%)	LOS (days)
Lacy	2002										
Open		108	193*	118		55 hours	85 hours	31	2	18*	7.9*
Lap		111	105	142*	11	36 hours*	54 hours	12	0	8	5.2
COST	2004		NA								
Open		428		95		NA	NA	21	NA	NA	6
Lap		435		150	21			20			5
MRCClasicc	2005		NA								
Open		268		135*		6d*	6	31	3	5	10
Lap		526		180	29	5d	5	29	4	4	8
Hewett	2008										
Open		298	100	107*		3.5 ± 1.6	3 ± 2.4	45.3%	3.4	8.7	10.6 ± 7.2
Lap		294	100	158	14.6	3.2 ± 1.7*	2.4 ± 1.5*	37.8%	1.4	5.8	9.5 ± 7.4*
COLOR trial	2009										
Open		542	175	115*		NA	NA	20	2	3	NA
Lap		534	100	145	17			21	3	4	

*$p < 0.05$.

Obesity has long been suggested as a risk factor for conversion to open surgery during laparoscopic colorectal resection. In general, difficulty identifying critical structures and impaired visibility due to visceral and omental fat are the most common scenarios leading to conversion. Conversion rates in recent series are listed in Table 1. The LCSSG study identified obesity as a risk factor for conversion; in particular, increasing BMI was correlated with a proportionally increased conversion rate (non-obese 5.5%; obesity with BMI < 35, 7.9%; obesity with BMI ≥ 35, 13.1%; $p < 0.001$).[25] Early data from our institution in devising a predictive model for conversion from our first 1253 laparoscopic colorectal resections also identified obesity as a predictive factor for conversion.[34] While this same, externally validated predictive model failed to be effective as a whole in predicting conversion in a series of 998 laparoscopic colorectal resections from the Mayo Clinic, Rochester, obesity remained an independent predictor of conversion in that same series when separately and independently analyzed.[35,36] Early reports of experience with laparoscopic colorectal surgery from our group suggested that conversion rates were higher amongst obese subjects undergoing laparoscopic colectomy. In particular, 14 of 59 (23.7%) patients in the obese group were converted to open surgery versus 22 of 201 (11%) non-obese ($p < 0.05$).[23] Our updated experience based on 2 case-matched groups of 436 patients in each did confirm that obesity is associated with conversion, as 31 of 436 (7.1%) conversions in normal weight individuals were compared with 58 of 436 (13.3%) in obese subjects, $p = 0.013$.[24] Reports from outside the United States also support the association between obesity and conversion. For example, a prospective, case-matched French study associated obesity with more than double conversion rate (32% versus 14%, $p < 0.01$).[26] Recent reports from Asia also concur with the findings from both European and American experiences; Chew et al evaluated 436 consecutive laparoscopic colorectal resections performed in Singapore and found on multivariate analysis that high BMI was an independent risk factor for conversion (OR 1.15, 95% C.I. 1.03–1.29).[32] Similarly, Park et al analyzed the outcomes of laparoscopic colorectal surgery in a Korean population of 984 patients, using the definition of obesity applied to the Asian population.[27] A total of 312 (31.7%) of their patients had a BMI of 25–29 (overweight by Western standards, obese class I in the Asian population) and an additional 27 patients in their series (2.7%) had a BMI >30 (obese by Western population definitions but obese class II in the Asian population). This latter group experienced an increased conversion rate when compared with either one of the remaining two groups (14.8% versus 2.6% and 2.9%, for overweight and normal weight, respectively; $p = 0.001$). Patients with BMI >30 had therefore an 8.36 fold increased risk of conversion to an open procedure. It is remarkable that obesity remained a factor associated with conversion even in this series from Asia where obesity is much less prevalent than in the Western countries, and sample sizes of obese patients were correspondingly smaller.

More recent contributions from single institutions with expertise in laparoscopic surgery would disagree with the contention that obesity predisposes to conversion. Li and colleagues evaluated their experience of 183 consecutive laparoscopic right colectomies and reported a conversion rate of 12%.[37] However, multivariate analysis did not identify obesity as a predictor of conversion in this study. Similarly, Leroy et al reported their experience on laparoscopic left colectomy in 123 obese subjects. All patients in their obese group had a successfully completed laparoscopic procedure while 5 of 88 patients in the non-obese group required conversion.[29]

Interestingly, few case series have extrapolated the reasons why laparoscopic cases have been converted. In our series, unclear anatomy (responsible for 14 of 58 (24%) conversions in obese patients versus 2 of 31 (6%) non-obese conversions, $p = 0.045$) and bleeding were more common in the obese, whereas in non-obese patients intra-abdominal phlegmon or abscess prevailed. These findings reflect analogous results from other reports in the literature. Pikarsky and colleagues cite bleeding, intra-abdominal adhesions and unclear anatomy as the main reasons why conversion was necessary.[31] Similarly, Kamoun et al analyzed 37 conversions in their case-matched series ($n = 180$) and found that T4 tumors, obesity, intra-abdominal adhesions and intestinal injury were the predominant complications leading to conversion.[26] Thus, it appears from the larger case series in the literature that obesity is predictive of conversion but this remains compatible with successful laparoscopic surgery in a significant proportion of the obese population.

RESTORATION OF BOWEL FUNCTION

The results from most of the RCT's, corroborated by their meta-analysis, have shown an earlier resumption of gastrointestinal function after minimally invasive colorectal resection.[7–11,38] For example, in the COLOR trial the first bowel motion occurred after a mean of 3.6 days following laparoscopic surgery versus 4.6 days following open resection and the Australian trial indicated shorter time to passage of flatus (3.2 vs3.5 days, $p = 0.027$) and first bowel motion (4.4 versus 4.9 days, $p = 0.011$). In contrast, the earlier MRC CLASICC trial did not show any significant difference in time to first bowel motion, irrespective of colonic or rectal resection. With respect to obese patients, early reports of laparoscopic resection indicated equivalent time in return of bowel function. In particular, in 2003 our institution reported an ileus rate of 5% in obese subjects in comparison to 2% in those of normal weight, which did not achieve statistical significance.[23] In our updated experience we again found no difference between time to first flatus compared with normal weight subjects (2.9 versus 3.1 days, $p = 0.361$), mean time to first bowel motion (5 days for normal weight subjects versus 5.3 days for obese patients, $p = 0.11$) and rate of post-operative ileus (4.8% of normal weight subjects versus 6% of obese subjects, $p = 0.33$).[24] Other series concur with our results. Leroy et al noted first passage of flatus 2.1 days after surgery in normal weight subjects compared with 2.2 days in the obese group. The rates of ileus were nil and 2.5% in the obese group and normal weight individuals, respectively.[29] In a German cohort of 589 consecutive patients undergoing laparoscopic resection, 95 obese patients had a mean time to first bowel movement of 4.5 days versus 4.1 days for 494 patients of normal weight; a difference which again was not statistically significant.[30] The LCSSS group found that 3.7 days was the mean time to first bowel motion in their cohort of 5,853 patients, regardless of the weight or degree of obesity of the patient.

In contrast with these data, Pikarsky et al reported on the Cleveland Clinic, Florida experience of laparoscopic colorectal surgery in obese patients and although they did not specifically comment on time to first passage of flatus or stool they did note that 10 of 31 (32.3%) patients in the obese group developed an ileus compared with 10 of 131 (7.6%) in the normal weight group ($p < 0.01$).[31] A limitation in the assessment of ileus as outcome reflecting the return of bowel function is the different definition of ileus used in different series. However, based on the large majority of the available evidence to date we conclude that there is no difference in time to resumption of gastrointestinal function in obese patients when compared with non-obese.

WOUND COMPLICATIONS

Obesity is a known risk factor for development of wound complications after conventional open colorectal resection.[39,40] Data from the American College of Surgeons National Surgical Quality Improvement Project (NSQIP) supports the finding that obese patients are more susceptible to wound infection. In a cohort of 3,202 patients, overweight patients (BMI 25–29) were more likely to develop septic wound complication (both superficial and deep) when compared with normal weight subjects (8% versus 5.5%, $p < 0.05$). Similarly, the morbidly obese (BMI >35) had a higher rate of surgical site infection when compared with individuals with a BMI< 35 (20.7% versus 9%, $p < 0.05$).[41] In general, several single institutional and retrospective series have indicated that laparoscopic colorectal resection is associated with a reduced incidence of wound infection.[42–44] However, results from the major RCTs did not uniformly confirm that the laparoscopic approach derives benefits in terms of adverse wound sequelae post-operatively, and reported the incidence after open surgery most commonly in single digits (Table 2). The data regarding wound complications after laparoscopic resection in the obese is similarly equivocal. Delaney et al in their case-matched series comparing laparoscopic colectomy and open colectomy in patients with BMI >30 did not find a significant difference in wound infection rates between the two groups (8 out of 94 in laparoscopic colectomy group versus 8 out of 94 in matched open colectomy group).[22] Earlier work from our institution also indicated that wound infection rates did not differ following laparoscopic resection in either obese or non-obese subjects.[23] Scheidbach and colleagues evaluated the wound infection rates after laparoscopic colorectal resection as part of the LCSSG multicenter study. They found a combined wound infection rate at either trocar or extraction sites of 5.6% in the non-obese, compared with 7.1% and 7.2% in those with Grade 1 (WHO definition of BMI 30–34.9) and Grade 2 (BMI 35–39.9) and 3 (BMI >40) obesity combined, respectively; a difference that did not reach statistical significance.[25] Teuch et al evaluated outcomes after laparoscopic sigmoidectomy for diverticulitis and again, found no difference in wound infection rates between obese and non-obese patients (5 of 48 versus 2 of 29, $p > 0.05$).[28] It is possible that patient selection and comorbidities play a significant role in wound infection rates, which does not help in understanding the specific impact of the laparoscopic approach. For example, a recent update of our institutional experience comparing obese and non-obese patients undergoing laparoscopic intestinal resection has shown that wound infection is significantly more common in obese patients (10.2 versus 4.4%, $p = 0.002$).[24] However, a potential confounder in this study was the finding that 14 of 46 (30.4%) patients in the obese group also had diabetes mellitus compared with only 1 of 21 (4.8%) in the non-obese group. Similarly, an earlier study by Pikarsky et al had reported a 12.9% wound infection rate in obese subjects in comparison to 3.1% in non-obese counterparts ($p = 0.03$). However, in this study a significantly increased proportion of obese patients also had comorbid conditions (52% versus 31%, $p = 0.03$).

While the data remains equivocal there is no clear evidence indicating that laparoscopic colorectal resection is associated with an increased rate of wound infection in obese subjects when compared with their non-obese counterparts. As our indications for laparoscopic resection expand to include an increasing number of patients with comorbidities potentially affecting wound infection rate we feel that a possible increase in wound infection rates in this subpopulation is not a sufficient reason to deter surgeons from offering laparoscopic surgery.

ANASTOMOTIC LEAK AND ABDOMINOPELVIC SEPSIS

Considering the technical difficulty of laparoscopic surgery in the obese it is not surprising that obesity has been regarded as a potential risk factor for the development of post-operative anastomotic leak after laparoscopic intestinal resection. In the wider patient population, a systematic review of the RCTs of laparoscopic versus open colorectal resections, totaling 4013 patients, showed that there was no difference in anastomotic leak rates between the 2 groups.[45] Our own institutional experience comparing leak rates following conventional open and laparoscopic surgery on 4,774 patients (1,516 laparoscopic and 3,258 open), also indicated no difference in the overall clinical leak rate between laparoscopic (2.6%) and open procedures (2.6% versus 2.1%, respectively; $p = 0.50$), even when assessing patient subgroups according to type of resection, indication, or year of surgery ($p = 0.40$).[34] In contrast, the initial experience examining obese pateints from our institution suggested that anastomotic dehiscence could be more common in obese patients,[23] with 3 of 59 (5%) obese subjects developing anastomotic leak compared with 4 out of 201 (2%) normal weight individuals ($p < 0.05$). However, in our most recent series with a larger number of patients the anastomotic leak rates were no longer statistically different after surgery in the obese versus non-obese patients (3.4% vs 2.1%, respectively, $p = 0.23$). The LCSSG study also did not find a difference in the number of anastomotic leaks between different weight groups (non-obese 1.7%, grade I obesity 2.5%, and grade II and III obesity 1.3%, $p = 0.423$). The early French series comparing outcomes of laparoscopic left colectomy in obese and normal weight individuals concurs with these results.

Few studies have specifically reported on abdominopelvic abscesses after laparoscopic colorectal resection. In this respect, both the early experience (3% rate in each group) and the most recent data from our group (2.3% in obese group versus 1.6% among non-obese) have shown similar rates of postoperative intra-abdominal abscesses.[23,24] Significantly, a comparison of the combined rates of anastomotic leak and abdominopelvic abscess in both groups also did not yield a significant difference, which replicates the experience of others.[26,31]

LENGTH OF HOSPITAL STAY

The three major RCT's performed in the last decade to evaluate laparoscopic versus open colorectal cancer have demonstrated that the minimally invasive approach results in earlier discharge from the hospital with a difference between the two arms ranging from 1 to 2 days among multicenter trials. Within the obese patient population, the case-matched study by Delaney and colleagues from our institution confirmed the benefit of laparoscopic surgery over open operation with a median LOS of 3 versus 5.5 days (mean 3.8 versus 5.8 days, $p < 0.001$).[22] With the limitation of a relatively small sample size and possible selection bias in spite of the case-matched design, these results would therefore indicate that the benefits of laparoscopic surgery in reducing hospital stay are even more pronounced among obese individuals than what is reported for laparoscopic colectomy in general. However, there is no consensus to date regarding whether obesity predicts a longer hospital stay for patients undergoing colonic or rectal surgery. Many potential confounders exist, as obese patients are more likely to have substantial co-morbid conditions, which may independently predispose to longer hospital stay. The LCSG study group assessed LOS in a large prospective multicenter study encompassing a large number of patients in Europe. The median LOS was 11 days for both non-obese and grade I obese patients, however it increased to 13 days for obesity grade II/III ($p = 0.005$).[25] Differences among mean values were more nuanced but grade II/III obesity was still associated with the longest LOS at 14 days. Hospital LOS data from other health care systems and societies are in general difficult to assess in comparison with the LOS for American patients. Specifically, a mean LOS of 11 days in the non-obese group of patients having laparoscopic surgery may reflect a more conservative approach to postoperative recovery pathways and patient discharge. However, other studies with smaller sample size have also noted a longer LOS in obese subjects. For example, the Cleveland Clinic Florida group did identify an association between obesity and longer LOS (9.5 days versus 6.9 days, $p = 0.02$).[36]

In contrast with these data, there is evidence supporting the opposing view that LOS is not associated with patients' weight. For example, data from our institution has consistently shown that LOS after laparoscopic intestinal resection is unaffected by weight. Original data from Senagore et al showed equivalent mean LOS of 4 days irrespective of whether the procedure was open or laparoscopic.[23] Despite increasing experience in laparoscopic surgery and expansion of the indications to laparoscopic surgery our most recently published data shows that LOS remains equivalent (mean of 5.4 days in either group).[24] Similar outcomes have been described from other units in Europe. A Czech group examined the effect of obesity on discharge from hospital in a cohort of 435 patients undergoing laparoscopic colorectal surgery, 80 of whom were obese. While obesity was associated with a longer hospital stay (mean of 12 versus 14 days), this did not reach statistical significance.[46] Leroy et al have actually described a shorter LOS in obese patients, with a mean of 7 versus 9.5 days in non-obese individuals ($p = 0.018$).[29] A large retrospective study evaluating outcomes after minimally invasive resection in the obese demonstrated a slightly longer LOS for obese patients although statistically insignificant (12.5 versus 13.4 days).[30] We therefore conclude that there is no convincing evidence that obesity results in a longer LOS after laparoscopic colorectal surgery.

CARDIOVASCULAR/THROMBOTIC COMPLICATION

There is little discernible evidence that cardiovascular, pulmonary and thromboembolic complications are higher in the obese population after laparoscopic colorectal resection. None of the major studies (Table 1) provides evidence that obesity predisposes to adverse post-operative outcomes after laparoscopic colorectal surgery in these categories of complication.

Hand-Assisted Laparoscopic Surgery (HALS) in Obese Patients

There is a dearth of available data comparing outcomes between HALS and standard laparoscopy in obese and non-obese patients. Our experience with HALS has shown that the procedure has equivalent outcomes in treatment of benign and malignant diseases of the colon. In evaluating our experience with HALS and laparoscopic right colectomy we found similar outcomes in the short and medium-term; the proportion of patients in either group who were obese was similar (33% versus 34%), however we did not evaluate outcomes based on BMI in either group.[47] The Mayo Clinic group has recently described short-term outcomes following laparoscopic colectomy for diverticulitis, comparing HALS with conventional laparoscopy. Overall morbidity, LOS, wound infection and conversion rates, ileus and anastomotic leak rates were equivalent between HALS and standard laparoscopy. Obese patients had a significantly higher conversion rate than those with normal BMI (18·8% versus 9·6%, $p = 0{\cdot}024$), and a higher wound infection rate in the postoperative period (17·0% versus 6·8% respectively, $p = 0{\cdot}004$). However, multivariate analysis was not performed comparing subgroup outcomes in patients having HALS or laparoscopic resection.[48] The same group has demonstrated that HALS can be utilized in surgery for Crohn's colitis, with equivalent results in terms of minor and major post-operative morbidity.[49] However, their experience does not comment specifically on outcomes between subsets of obese versus non-obese patients having HALS or conventional laparoscopy.

Our group has similarly shown that HALS can be performed as effectively as conventional laparoscopy and at no extra cost.[50] Specifically, the learning curve for performing HALS colectomy in our institutional series was for speed, not perioperative morbidity or recovery.[51]

In evaluating their experience with HALS in urologic surgery, Montgomery et al found that obesity was associated with HALS incision site infections ($p = 0.03$), however no comparison to standard laparoscopy was available.[52] Sonoda et al have demonstrated equivalent long-term complications between either procedure in terms of small bowel obstruction and incisional hernia, at a median follow-up of 27 months.[53]

A recent systematic review by Alabers et al suggested that HALS may have the advantage of laparoscopic surgery over open surgery while reducing some of the disadvantages of laparoscopic surgery (shorter operative time, lower conversion rates).[54] Especially for indications in which an incision to extract the resection specimen is required, HALS provides an excellent treatment option. Thus, we believe that HALS may be an excellent option for obese patients, allowing insertion of a sponge into the abdominal cavity to pack the omentum into the upper abdomen, and similarly the operating surgeon's hand can be used to facilitate exposure. This may have the added benefit of allowing faster completion of the operation using a minimally invasive technique in a high-risk group of patients. Since specific data on hand-assisted colorectal resection in the obese population remains scarce further investigations in this area are needed.

CONCLUSIONS

Laparoscopic colorectal resection is safe in the obese population. Available evidence in the published literature, albeit limited, would suggest that in comparison to non-obese subjects, operations on obese patients take longer and conversion rates are higher. The incidence of wound sepsis, anastomotic leak rates, blood loss/transfusion requirements, adverse cardiopulmonary and thrombotic sequelae and length of stay are probably equivalent. We conclude that laparoscopic colorectal resection can be successfully completed and should be offered to obese patients considering its benefits when compared with conventional open surgery.

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