Complications Following Colon Rectal Surgery in the Obese Patient

Timothy M. Geiger, M.D.[1] and Roberta Muldoon, M.D.[1]

ABSTRACT

It is well recognized that obesity contributes to multiple co-morbidities, and it would seem intuitive that obese patients experience an increase in post-operative complications after colorectal surgery. Overall, the data examining postoperative morbidity and mortality in the obese colorectal patient is inconsistent. Studies have shown a trend for obese patients have a higher post-operative risk of pulmonary embolism, atelectasis, cardiac complications, and thromboembolic disease. However, even with multiple large trials concluding this, there are also many studies showing no difference. The literature has shown that using laparoscopic techniques is safe and feasible, but there is a higher rate of conversion to open, and longer operative times. In addition, obese patients might have a higher leak rate for distal anastomosis as compared with normal weight patients. These patients also have a higher post-operative rate of stomal complications and fascial dehiscense. In reviewing the literature, at best, the complication rate in obese patients is the same as non-obese patients after colorectal surgery, but there are significant trends that suggest a negative effect of obesity after colorectal surgery.

KEYWORDS: Obesity, colorectal surgery, complications

Objectives: On completion of this article, the reader should be able to: (1) summarize the current literature's view on the effects of colorectal surgery on obese patients; and (2) understand the complexity of obesity in the post-operative care of patients after colorectal surgery.

Many surgeons would share the notion that surgery in the obese patient is not only technically more challenging, but fraught with higher post-operative complications than non-obese patients. This belief may be rooted deep in anecdotal memories and past experiences. However, while there is a significant belief in the high post-operative complication rates due to obesity, the scientific literature generally is sparse and inconsistent in findings.

There are significant issues with the currently available literature examining post-operative complications in the obese patient. The most basic problem is the definition of obesity. Published studies have not used standard criteria for what defines an obese patient. Early studies favored the ideal body weight (IBW) to define obesity. Even within this parameter, some have used >20% IBW some, >30% IBW. Body mass index (BM–kg/m^2) is currently the most commonly employed measure . Again, while the calculation of BMI is standard, the definition varies among studies as some authors use a BMI >25 kg/m^2 while others use 27 kg/m^2 or 30 kg/m^2 to denote obesity. Others have broken obesity into

[1]Colon and Rectal Surgery, Department of Surgery, Vanderbilt University Medical Center, Nashville, Tennessee.

Address for correspondence and reprint requests: Timothy M. Geiger, M.D., Colon and Rectal Surgery, Department of Surgery, Vanderbilt University Medical Center, 1161 21st Ave. South, D-5248 MCN, Nashville, TN 37232-2543 (e-mail: timothy.geiger@vanderbilt.edu).

Colon and Rectal Surgery in the Obese Patient; Guest Editor, H. David Vargas, M.D.

Clin Colon Rectal Surg 2011;24:274–282.
DOI: http://dx.doi.org/10.1055/s-0031-1295692.
ISSN 1531-0043.

multiple categories—overweight BMI 25–29 kg/m^2, obese 30–34 kg/m^2, and morbidly obese >35 kg/m^2. The variability in measurement can greatly affect the power of a study's calculation, and can affect the statistical result.

Unfortunately with this mixed definition, it can be hard to compare varying studies and to draw firm conclusions from the currently published data. In addition, obesity not only affects the technical aspect of the surgery itself, but also has a significant effect on the patient's comorbidities, functional status, and postoperative care which in turn affects postoperative outcomes and complications.

Further complicating this discussion, in addition to multiple definitions of what is considered obese, there remains significant variability of what is considered a complication. This makes interpretation of the literature even more difficult. Large retrospective databases using nation-wide data, such as the American College of Surgeons National Surgical Quality Improvement Project (NSQIP) database, and other administrative databases have tried to help eliminate some reporting variables, but even when the same database is used, results differ between publications.

In this section we will review the available literature as it related to the complications following colorectal surgery in the obese patient. Overall the literature is mixed when looking at post-operative complication of obesity. At best, postoperative complications in the obese patients are equivalent to the rate of complications in the non-obese populations, but there are significant trends and some large studies that point to an increase in post-operative complications in the obese patient.

OVERALL MORBIDITY AND MORTALITY

Colorectal surgery is associated with significant risks, but the reported morbidity and mortality rate varies greatly in the literature. This is presumably due to variation in definitions of complication and differences in reporting. Large administrative databases have reported morbidity after colorectal surgery to range from 2% to 20% for both elective and emergent cases.[1,2] Some centers report elective mortality in the 1.5% range.[3] Morbidity data are also varied, with ranges from 20–45%.[1,4] There is also considerable variation on what constitutes a complication, along with what is a "major" complication versus a "minor" one. The true incidence of mortality and morbidity probably lies in the some near the median of the reported ranges.

Obesity has been examined as a risk for mortality and morbidity in both non-cardiac surgery and in colorectal specific populations. For patients undergoing non-cardiac surgery, early studies showed a paradoxical reduction in mortality after surgery.[5–10] However, a follow up study that examined obese patients without significant comorbidities against obese patient with comorbidities showed a 2 fold increase in mortality after surgery, and a significant increase in major morbidity after surgery.[11] A retrospective review of the NSQIP data for mortality and morbidity also showed that obesity was a statistically significant risk factor for both perioperative morbidity and mortality.[12] Some studies however, have not found similar results. Dindo et al did not show a difference between obese patients (BMI >30 kg/m^2) and non-obese patients for morbidity or mortality using a large prospectively collected database of patients (6336 patients) undergoing general surgical procedures.[5]

The data looking at colorectal specific cases seem to mirror the non-cardiac surgery data. There are many studies showing a difference in mortality and morbidity in the obese patient as compared with non-obese. However, there are also studies showing no difference. An early study by Hickmann et al looked at IBW, and found that those considered obese had a higher 30 day morbidity (48%) and mortality (14%) as compared with normal weight patients (19% and 3%).[13] Another study by Ondrula et al examined 17 preoperative risk factors including weight >30% IBW, but did not find a statistically significant difference in mortality or morbidity between groups.[14] Merkow et al performed a large review of NSQIP data showed that morbidly obese patients (BMI >35 kg/m^2) were at greater risk for morbidity when compared with normal weight, overweight and obese patients, with similar morbidity between the other three groups (BMI <25 kg/m^2, BMI 25–29 kg/m^2, or BMI 30–34 kg/m^2).[15] Benoist et al reported retrospective review of 30 outcome variables and found no difference in 30 day mortality or morbidity in obese patients (BMI >27 kg/m^2) undergoing either right or left colon resections in patients with BMI >27 kg/m^2.[16]

Overall, the results of examining the effect of obesity for complications and death after colorectal surgery are mixed. Some large studies did find a difference in mortality and morbidity in obese patients, which showed that obesity is a risk factor for adverse outcome. However, there are other published studies showing no difference. One can agree that while early non-cardiac surgery studies showed a paradoxical protective effect of obesity after surgery, more recent analysis reveal that at best, outcomes in the obese are equivalent to normal weight patients with respect to the overall risk of surgery, and may increase the risk of complication and death.

One important trend in the literature involves differentiating obese patients without associated comorbidities (healthy obese) from those with comorbidities, and comparing these groups for complication. However, differences found between these groups could be attributable to the comorbidities and not obesity as an independent risk factor. The complexity of defining and capturing morbidities confounds results seen in the literature.

SPECIFIC COMPLICATIONS

Pulmonary Complications

Obesity has significant impact on the respiratory system. The effects of obesity can be seen at multiple points throughout the process of respiration including compliance, volumes, and exercise capacity. All of these effects contribute to an increase in pulmonary complications in the obese patient undergoing colorectal procedures.[17–21]

Obese patients have long been felt to have an increased risk in pulmonary complications in the perioperative period. Reviews of the literature have reported pulmonary complications in a large range (5–35%) in the obese colorectal patient.[1] A large review of the 2008 American College of Surgeons National Surgical Quality Improvement Project (NSQIP) data compared normal weight patients (BMI 18.5–24 kg/m^2) to overweight (BMI 25–29 kg/m^2), obese (30–34 kg/m^2) and morbidly obese patients (BMI >35 kg/m^2) undergoing noncardiac surgery.[11] They separated obesity into two classes-healthy obese, and obese with "metabolic syndrome" (central obesity, hypertension, hyperglycemia, dyslipidemia, and prothrombotic/inflammatory states). They found an increase in pulmonary complications (pneumonia, ventilator support >48 hours, or unplanned reintubation) in overweight, obese, and morbidly obese patients as compared with normal weight patients. In addition, the risk was significantly higher in overweight, obese, and morbidly obese patients if they also had the "metabolic syndrome". One limitation to the application of this study to the colorectal population was the inclusion criteria, where only 51% of the study group had "gastrointestinal surgery". A second study examining the same NSQIP population, looked specifically at patients undergoing colectomy for the diagnosis of colon cancer.[16] Pulmonary complications examined were diagnosis of pneumonia, pulmonary embolism, respiratory failure, or mechanical ventilation >48 hr postoperative. They found only a statistically significant association between the risk of postoperative pulmonary embolism when comparing normal BMI patients to the overweight, obese, and morbidly obese patients. No other complication was found to be significant.

Other published reports examining colorectal procedures have had mixed results. Benoist et al did not find an increase in pulmonary complications in those with a BMI >27 kg/m^2.[16] Kaumon et al (obesity defined as BMI >30 kg/m^2) examined post-operative pneumonia and found no significant difference between the two groups.[22] Interestingly, these authors specifically looked at laparoscopic colorectal procedures, whereas other studies had examined pulmonary complications after open procedures. In matched comparisons of laparoscopic versus open colon resection Delaney et al found no difference in post-operative pulmonary complications in obese patients who underwent a colon resection by either technique.[23] Pollard et al found that atelectasis was higher in patients with a higher BMI.[24]

There is convincing data that obesity is a risk for atelectasis and pulmonary embolism, and some data would suggest that laparoscopic colorectal surgery may have less risk compared with laparotomy. NISQIP data showed a difference in obese versus non-obese patients undergoing noncardiac surgery, but this was not seen on a second review of the NISQIP data looking at colorectal patients. Even though BMI was used for measure obesity, the breakdown of groups was different between the two reviews, which could account for the difference in outcome. While the data suggests an increase in the postoperative pulmonary complications in obese patients, the non-standardized definitions of obesity, retrospective reviews, and pooling of data containing numerous types of abdominal procedures has made interpretation of the available literature complex.

Cardiovascular Complications

The known effects of obesity on the cardiovascular system are numerous and significant. Obesity effects insulin resistance and diabetes, causes hypertension, dyslipidemias, heart failure, arrhythmias, and coronary heart disease, among multiple other derangements in normal function of the heart and vascular system.[25] While the literature is extensive in the study of the effects of obesity on the cardiovascular system, there is sparse literature outlining the postoperative cardiovascular complications seen in the obese colorectal patient.

A published retrospective examination of the NSQIP data for all non-cardiac surgery, did not find an increase in the incidence of cardiac events (defined as myocardial infarction or cardiac arrest) when comparing patients with a normal BMI (18.5–24 kg/m^2) to overweight (25–29 kg/m^2), obese (30–34 kg/m^2), or morbidly obese (>35 kg/m^2) populations.[11] However, when they examined the subgroup of patients that were overweight, obese, or morbidly obese and had central obesity, hypertension, hyperglycemia, dyslipidemia, and/or prothrombotic/inflammatory states, they found a 2–3 fold increase in cardiac complications as compared with the normal weight population. In another study that took the same NSQIP data and specifically looked at patients who underwent colon resections, they found no increase in the incidence of either myocardial infarction or cardiac arrest when comparing patients with a normal BMI to overweight, obese, or morbidly obese patients.[15]

In a single center study of postoperative complications in obese patients undergoing noncardiac surgery, they found a statistically higher prevalence of myocardial infarction in the obese versus nonobese patients.[12] They reported only 3.9% of the surgeries were defined as gastrointestinal. Studies more specific to colorectal surgery have been mixed, but suggest an increase in the

cardiac risk. Benoist et al found a statistical difference in cardiac complications, defined as myocardial infarctions, heart failure and arrhythmias in patients undergoing a right colectomy with a BMI >27 kg/m^2.[16] However, they were not able to demonstrate the same finding when examining left colectomies or rectal resections. In another single center experience, Pollard et al examined patients undergoing radical surgery for rectal cancer and found a statistically significant association between patients with body weight >30% over their ideal body weight (IBW) and cardiac failure (as defined as cardiac arrhythmias or myocardial infarction).[24]

Overall the data evaluating the risk of cardiac complications after colorectal surgery in obese patients is mixed, but with a trend showing increased risk in the obese population. The NISQIP data, examining retrospective administrative data from multiple centers showed no difference between obese and non-obese patients undergoing colorectal surgery. An interesting subgroup analysis showed that obesity and other comorbidities did increase the risk of cardiovascular complications. Single center data are also mixed, but when obesity was combined with other comorbidities, did have increased risk of complications.

Thromboembolism

Obese patients have increased inflammatory factors, elevated plasma fatty acid levels, and decreased antithrombin III, all leading to a predisposition for thromboembolic disease.[26–28] Despite these risk factors literature examining the deep vein thrombosis (DVT) risk for obese patients is inconsistent.[29]

A large review of the NSQIP data specifically examined venous thromboembolism in 52,555 patients undergoing colorectal surgery.[30] In the analysis, BMI >30 kg/m^2 was one of the three patient risk factors that were statistically significant. Open surgery was also found to be a statistically significant risk factor as compared with laparoscopic surgery in this population. A second retrospective review of the NSQIP data examining the effect of BMI on short term outcome did not find a statistically significant difference between normal weight patients (defined by BMI), and overweight/obese patients in DVT risk, but did find a significant difference when examining the incidence of pulmonary embolism.[15]

Single institution reports have not found any association between colorectal surgery in obese patients and the risk of DVT. In a study of 111 patients, Senagore et al examined postoperative complications from laparoscopic colectomies in normal weight patients compared with obese patients (BMI >30 kg/m^2).[31] They did not find any difference in the rate of DVTs. Benoist et al and Blee et al also looked at DVT rates between normal weight patients and obese patients after colorectal surgery and also found no difference.[16,32]

Most authors would agree that obesity is a risk factor for thromboembolic disease, and therefore would hypothesize that obese patients undergoing colorectal surgery would be at increased risk for DVT/thromboembolic disorders. Large administrative databases (NSQIP data) does show a difference with increased complications in the obese colorectal patient. Single institution data are mixed. Some confounding issues are the combined reporting of both laparoscopic technique and open technique patients, and the higher prevalence of inflammatory bowel disease (IBD) patients in the colorectal populations.

Laparoscopic versus Open Surgical Technique

Laparoscopic surgery has been shown to have significant benefits for those patients eligible for this technique. These benefits include decreased post-operative pain, decrease length of stay, decrease recovery time and improved cosmesis. It was questioned if laparoscopic surgery could be performed safely in the obese patient and would these above mentioned benefits be transferrable to this particular group of patients. To examine the feasibility of the laparoscopic technique in obese patients, Balentine et al did a retrospective data review and identified 155 obese patients who had undergone colorectal cancer surgery.[33] Open procedures were performed in 73% of the cases, while a laparoscopic approach was used in 27%. The laparoscopic group revealed a trend toward decreased surgical site infection (21% compared with 28%; $p < 0.644$) however this did not reach statistical significance. The review also demonstrated that the laparoscopic group had return of bowel function and was discharge home on average 2 days sooner than those in open cohort ($p < 0.003$). Specimens from procedures that were performed laparoscopically were comparable to those from the open cases with regard to the oncologic resection including the number of lymph node extraction as well as the proportion of margin negative resections. These and other studies have shown that it is technically feasible to perform laparoscopic surgery on the obese patient and that obese patients experience the same benefits as do non-obese populations.

While the laparoscopic approach is feasible, studies have shown an increased conversion rate found with the obese patients who underwent laparoscopic resection. Pikarsky et al reported an overall conversion rate of 18%.[34] When broken down, the patients with a BMI >30 kg/m^2 were more likely to need conversion when compared with a non obese patient. (39% vs 13.5%, $p = 0.01$) The rate of conversion in the literature ranges from 11% to 39%.[31,33–38] Interestingly, the reason for conversion in the obese group was more likely to be from poor visualization secondary to intra-abdominal fat or bleeding, where as the most likely reason for conversion in the non-obese group was adhesions.

It was generally accepted that obesity increased the complication rates with laparoscopic surgery. The data on this has not been consistent. Many studies suggest that obese patients do indeed have a higher complication rate. Pikarsky evaluated 162 patients who underwent elective laparoscopic colorectal surgery.[34] He found that obese patients had significantly more post-operative complications compared with normal weight patients (78% vs 24%, p=<0.01). Ileus (32.2 versus 7.6% $p < 0.001$), wound infections (12.9 vs 3.1, $p = 0.03$) as well as mean hospital stay (9.5 days vs 3.1) were also significantly higher in the obese group when compared with normal weight patients. Senagore et al, in their review, also found that obese patients had a higher morbidity compared with non-obese patients (22% versus 13%).[31] Khoury et al found similar results.[35] They reviewed 436 obese patients who had undergone laparoscopic bowel resection and were case-matched to an equal number of non-obese patients. Obesity was associated with a significant increase in post-operative morbidity with an overall rate of 32.1% versus 25.7% for obese and non-obese patients respectively. Wound infections were also more common in the obese group of patients with a rate of 10.6% compared with 4.8% in the non obese group ($p = 0.002$).

There have been a few studies that showed trends toward an increase in complications for obese patients however these did not reach statistical significance. A second study by Khoury re-evaluated 36 patients which were grouped according to BMI.[36] Patients were stratified to either obese (BMI >40 kg/m^2) or non-obese (BMI <30 kg/m^2). The obese patients were found to have a higher rate of wound infection, anastomotic leak, and abdominal abscess as well as higher readmission and reoperative rates. This trend did not reach statistical significance, which may be attributed to the small sample size of the study. Dostalik et al saw similar trends.[39] They evaluated 435 patients that had undergone elective laparoscopic colorectal surgery. There were 80 patients (18%) in the obese group (BMI >30 kg/m^2) and 355 patients (82%) in the non-obese group (BMI <30 kg/m^2). Post-operative complications were more frequent in the obese group (33% vs 24%). They also saw more frequent re-operations in this same group (13% vs 7%). These did not reach statistical significance.

There are some studies that do not show an increased complication rate in the obese patient. Healy et al evaluated 414 patients and grouped them according to their body mass index (BMI).[40] Underweight patients were those with a BMI <20 kg/m^2, normal weight were those 20–25 kg/m^2, overweight was considered 25–30 kg/m^2, and obese were those patients that had a BMI of ≥30 kg/m^2. They found that there was no difference between the groups with regard to the overall incidence of major complication ($p = 0.244$) or minor complications ($p = 0.078$) with the exception of an increase in the number of pelvic abscesses found in the obese group (BMI >30 kg/m^2). Sarli et al evaluated 181 laparoscopic left hemicolectomies and also found no significant difference with regard to post-operative complications between the obese and non-obese patient groups.[41]

Overall, the literature shows that not only is laparoscopic surgery technically feasible in the obese colorectal patient, but these patients also benefit from it application just as in non-obese populations. The literature does show that increased BMI does increase the rate of conversion from a laparoscopic procedure to an open procedure. The data examining the postoperative complications when using a laparoscopic technique in obese patients is mixed with some studies reported higher complication rates, and some showing no difference compared with non-obese populations undergoing colorectal surgery.

Anastomotic Leak

Symptomatic anastomotic leak represents a major and perhaps most feared complication after bowel resection. Various risk factors have been identified. Patient factors that have been shown to increase the risk of anastomotic leak include male gender, malnutrition, weight loss, hypoalbuminemia, ETOH use, and preoperative steroid use.[42–44] Operative factors that have been shown to be linked to an increase risk of anastomotic leak include level of anastomosis, length of surgery, ASA classification, administration of blood transfusions and intraoperative contamination.[43,44]

Benoist et al examined the role that obesity plays in the risk stratification for anastomotic leak.[16] From 1990 to 1997, 584 consecutive patients underwent elective colorectal resection. Of these, 158 were obese (BMI >27 kg/m^2) and 426 were not obese (BMI <27 kg/m^2). The results were analyzed based on the location of the resection. As might be expected, there were significantly greater number of patients with diabetes and cardiac disease in the obese group compared with the non-obese group. In the right hemicolectomy group, there was no significant difference in leak rates, and the same was true of left colectomy.

Obesity had its strongest effect in the group of patients that underwent rectal resections. Clinical anastomotic leaks occurred in 16% of the obese patients and 7% of the non-obese patients which was statistically significant ($p < 0.05$). Breaking this down further, they found that after coloanal anastomosis, the leak rate was comparable in both groups however in the colorectal anastomotic group, the leak rate was significantly higher in the obese group compared with the non-obese group (17% vs 6%, $p < 0.05$). They concluded that obesity has only minimal effect on the post-operative course after

elective right or left colectomy.[16] However, in the rectal resection group, obesity had a significant effect on leak rate, wound infection, and post-operative hemorrhage. Multivariate analysis showed that diabetes mellitus and ASA status were significant risk factors for anastomotic leakage in the obese patient. Rullier et al looked at the risk factors for anastomotic leak after rectal resection for cancer.[45] This retrospective study looked at 272 consecutive resections for rectal cancer. The overall leak rate was 12% (32 of 272). In the low anastomosis group, the leak rate was 19% (25 of 131). When evaluating for all anastomoses, multivariate analysis showed that only gender and level of anastomosis were independent associated factors for the development of an anastomotic leak. The risk of leak was 2.7 times higher in men than women. The risk of leak was 6.5 times higher if the anastomosis was located at or below 5cm from the anal verge compared with those located above that level. When evaluating for just low anastomoses, obesity was a significant risk factor for the development of a leak.

There have been others that have looked at the effect of obesity on rate of anastomotic leak under specific circumstances. Kiran et al reviewed the complications and functional results after ileopouch anal anastomosis in the obese patient.[42] This was a retrospective analysis from a prospectively collected database. They had 1,671 non-obese patients and 345 obese patients (BMI $>30 kg/m^2$). They found that the obese patients had a significant higher chance of developing a complication. Obese patients had a significantly higher chance of developing a wound infection (18.8% vs 8.1%, $p < 0.001$) as well as a higher chance of developing an anastomotic separation (10.4% vs 5.4%, $p < 0.001$). Biondo et al looked specifically at risk of leak after resection and primary anastomosis after left sided colonic emergencies.[43] A total of 208 patients who had undergone an emergent resection and reanastomosis for a left sided colonic emergency were evaluated. One hundred five patients (50.4%) developed at least one complication. Anastomotic leak occurred in 5.7% of the patients. Obesity was found to be an independent risk factor in the development of an anastomotic leak.

Unfortunately, definitions of anastomotic leak varied among the studies making comparisons and interpretation limited. In spite of this, the weight of the literature suggests that there is an association between obesity and an increased risk of developing an anastomotic leak. Some studies that did not reach statistical significance may be due to small sample size and lack of power. Of note is the literature examining the rate of leak in rectal resections which appears to suggest a greater risk of leak with more distal colorectal and coloanal anastomoses as compared with the risk of leak in obese patients undergoing segmental resections (right or left colectomy).

Hernia/Dehiscence

Abdominal wound dehiscence is the complete separation of all layers of the abdominal wall and is associated with a higher morbidity and mortality. The rate of occurrence of this complication for major abdominal procedures ranges from 0.5–2.58%.[46–48] There have been many risk factors which have been identified. Age over 65, emergency operation, cancer, wound infection, hypoalbuminemia, steroids, hemodynamic instability, intra-abdominal sepsis, ascites and obesity have all been identified as risk factors.[46,47] Gender, anemia and diabetes mellitus were not found to be significant risk factors.[46,47] Merkow et al evaluated the effect of BMI on short-term outcomes after colectomy for cancer.[15] They identified 3,202 patients who had undergone a colectomy for cancer from 121 participating hospitals in the ACS NSQIP database. Of these patients 1,072 (33.4%) were normal weight (BMI 18.5–24 kg/m^2), 1,127 (35.2%) were overweight (BMI 25–29 kg/m^2), 607 (19.0%) were obese (BMI 30–34 kg/m^2), and 396 (12.4%) were morbidly obese (BMI $>35 kg/m^2$). On univariante analysis the normal, overweight and obese groups had similar overall complication rates (20.5% vs 23.9% vs 22.9%, respectively). Morbidly obese patients however suffered from a significantly higher rate of complications compared with the normal weight group (31.8% compared with 20.5%). Specifically, the morbidly obese group had a higher rate of surgical site infections (20.7% vs 9.0%), including superficial infections (13.1% vs 5.5%), deep infections (2.0% vs 0.7%) and wound dehiscence (3.3% vs 1.1%). Multivariable logistic regression models were developed to evaluate the independent impact of BMI on specific complications. It was found that the morbidly obese patients were significantly more likely to develop a wound dehiscence (OR 3.51, 95% CI 1.55 to 7.95).

Incisional hernias are a late complication of abdominal surgery with an overall estimated incidence ranging from 2–11%.[49] However, this estimation is most likely underestimating the true number in that up to one-third of incisional hernias are asymptomatic and therefore many may go undiagnosed. There are many factors which have been associated with as a high risk for developing an incisional hernia. Some of these include chronic lung disease, steroids, diabetes mellitus, malnutrition and jaundice. Obesity has also been implicated as a risk factor. Sugerman et al compared patients that were having open gastric bypass to those having a total abdominal colectomy with IPAA (ileopouch anal anastomosis) for ulcerative colitis.[47] He found that the hernia rate was 20% for the bypass patients (19% for those who had never had a hernia versus 41% for those that had had a prior hernia) compared with only 4% for the UC patients, of whom 60% were on chronic steroids. He concluded that obesity is a strong risk factor for the development of an incisional hernia. Obesity has also

been implicated in the high recurrence rates after initial hernia repair. Vidovic et al studied 297 patients who had undergone incisional hernia repair.[48] They found an overall recurrence rate of 30.3%. This was broken down further and found to have a recurrence rate of 39.4% for those with a suture repair versus 14.6% for those with a prosthetic mesh repair. They also found a statistically significant relationship between obesity and recurrence of the hernia. This association was also found by Sauerland.[49] He prospectively followed 160 patients who underwent incisional hernia repair. The patients had a recurrence rate of 11% and again obesity was a significant predictor for recurrence of the hernia. Though the specific mechanism is not know, it is thought that it may be due to several factors including hypoxic tissue, increase tension on the wound, and increased risk of infection.

Overall, there is convincing evidence that the risk of wound and fascial dehiscence is increased with obesity as compared with a non-obese population. This has been seen in both the general surgery literature and studies specific to colorectal surgery. Studies have also confirmed the increased risk in incidence of postoperative hernia after abdominal surgery in the obese patient. The lack of colorectal specific studies examining the association of obesity to post-operative hernia limits any conclusion to the extrapolation of results from general abdominal surgery literature. Based on this data the association of obesity and an increased risk of hernia seem valid.

Stoma Complication

Stomas are created either because an anastomosis is not possible or there is a need to divert stool away from a section of distal bowel. Often times a protective stoma is created to minimize the effect of a possible anastomotic leak and reduce the clinical sequela from that complication. Stomas however can have their own complications which can be quite menacing problems. It has been reported that stoma complications may be as high as 58.1% in some studies.[50] It is not surprising that obese patients have a higher risk of developing stoma complications. From a technical standpoint, they often have shortened; thick mesenteries which preclude ease of bringing the stoma to the skin through a thick subcutaneous layer. This also increases risk of retraction as well as necrosis, both of which can lead to pouching difficulties and skin irritation. In a case controlled study, Duchesne et al[51] reviewed 164 patients and found an overall complication rate of 25%. The complication rate for ileostomies was 35.6% where as it was 21.8% for colostomies. Significant predictors of stoma complications were found to be inflammatory bowel disease, ischemic colitis and obesity. After multivariant analysis only inflammatory bowel disease and obesity were significantly associated with complication (OR = 2.66; 95% confidence interval = 1.15–6.16). In the obese patient the most likely complications experienced were skin irritation(21%), prolapse, (21%) and necrosis(21%), followed by stenosis (14%), infection (14%) and bleeding (7%). Leenan et al performed a retrospective analysis of 266 patients that underwent 345 stomas.[52] For those patients with a BMI of >30 kg/m^2 a higher overall number of stoma complications was seen compared with the normal weight patients(47% vs 36% $p < 0.05$). Arumugam found that obese patients had a higher risk of retraction, early skin excoriation and poor siting.[53] A trained enterostomal nurse can decrease some of these complications so perioperative involvement is extremely beneficial to these patients.

CONCLUSION

Obese patients represent a significant challenge for colorectal surgeons. The current literature has failed to set a standard for the definition of obesity, and even has variability within the measurement of body weight to define who is obese and who is not. Due to this variability the published literature does not help affirm or dispute the commonly held belief that obese patients are at higher risk for intra-operative and post-operative complications. Looking at the overall mortality and morbidity of colorectal surgery, at best the obese patient is at equal risk to the non-obese, but there are multiple studies showing a higher risk comparing the two groups. Pulmonary and cardiac complication data also trends toward an increased risk in the obese population. The available data does support the use of laparoscopic techniques in the obese patient, but also shows a trend of higher conversion rates, and longer operative times in the obese patient. Anastomotic leak rates are reported to be higher in obese patients for distal colorectal anastomoses, but not different for segmental colectomies more proximal. In addition the current literature suggests and increased risk in fascial and wound dehiscence, and possibly in post-operative hernia rates, but caution must be exercised in that a large portion of data quoted is extrapolated from general abdominal cases, and not colorectal specific surgeries. Stoma complications also are suggested to be higher in the obese population.

Overall, the literature on the effect of obesity on post-operative complications in colorectal surgery is sparse and confusing due to multiple definitions used as variables. With multiple studies that confirm an increase in complications in the obese colorectal patient, and other studies that deny an increase in complications, it is difficult to know what the true effect of obesity is on the postoperative complications after colorectal surgery.

REFERENCES

1. Gendall KA, Raniga S, Kennedy R, Frizelle FA. The impact of obesity on outcome after major colorectal surgery. Dis Colon Rectum 2007;50(12):2223–2237
2. Ragg JL, Watters DA, Guest GD. Preoperative risk stratification for mortality and major morbidity in major colorectal surgery. Dis Colon Rectum 2009;52(7):1296–1303
3. Killingback M, Barron P, Dent O. Elective resection and anastomosis for colorectal cancer: a prospective audit of mortality and morbidity 1976–1998. ANZ J Surg 2002; 72(10):689–698
4. Ansari MZ, Ackland MJ, Jolley DJ, Carson N, McDonald IG. Inter-hospital comparison of mortality rates. Int J Qual Health Care 1999;11(1):29–35
5. Dindo D, Muller MK, Weber M, Clavien PA. Obesity in general elective surgery. Lancet 2003;361(9374):2032–2035
6. Klasen J, Junger A, Hartmann B, et al. Increased body mass index and peri-operative risk in patients undergoing non-cardiac surgery. Obes Surg 2004;14(2):275–281
7. Smith PW, Wang H, Gazoni LM, Shen KR, Daniel TM, Jones DR. Obesity does not increase complications after anatomic resection for non-small cell lung cancer. Ann Thorac Surg 2007;84(4):1098–1105; discussion 1105–1106
8. Mullen JT, Davenport DL, Hutter MM, et al. Impact of body mass index on perioperative outcomes in patients undergoing major intra-abdominal cancer surgery. Ann Surg Oncol 2008;15(8):2164–2172
9. Davenport DL, Xenos ES, Hosokawa P, Radford J, Henderson WG, Endean ED. The influence of body mass index obesity status on vascular surgery 30-day morbidity and mortality. J Vasc Surg 2009;49(1):140–147; 147; e1; discussion 147
10. Mullen JT, Moorman DW, Davenport DL. The obesity paradox: body mass index and outcomes in patients undergoing nonbariatric general surgery. Ann Surg 2009;250(1):166–172
11. Glance LG, Wissler R, Mukamel DB, et al. Perioperative outcomes among patients with the modified metabolic syndrome who are undergoing noncardiac surgery. Anesthesiology 2010;113(4):859–872
12. Bamgbade OA, Rutter TW, Nafiu OO, Dorje P. Postoperative complications in obese and nonobese patients. World J Surg 2007;31(3):556–560; discussion 561
13. Hickmann DM, Miller RA, Rombeau JL, Twomey PL, Frey CF. Serum albumin and body weight as predictors of postoperative course in colorectal cancer. J Partenter Enteral Nutr 1980;4:314–316
14. Ondrula DP, Nelson RL, Prasad ML, Coyle BW, Abcarian H. Multifactorial index of preoperative risk factors in colon resections. Dis Colon Rectum 1992;35(2):117–122
15. Merkow RP, Bilimoria KY, McCarter MD, Bentrem DJ. Effect of body mass index on short-term outcomes after colectomy for cancer. J Am Coll Surg 2009;208(1):53–61
16. Benoist S, Panis Y, Alves A, Valleur P. Impact of obesity on surgical outcomes after colorectal resection. Am J Surg 2000;179(4):275–281
17. Koenig SM. Pulmonary complications of obesity. Am J Med Sci 2001;321(4):249–279
18. Harik-Khan RI, Wise RA, Fleg JL. The effect of gender on the relationship between body fat distribution and lung function. J Clin Epidemiol 2001;54(4):399–406
19. Canoy D, Luben R, Welch A, et al. Abdominal obesity and respiratory function in men and women in the EPIC-Norfolk Study, United Kingdom. Am J Epidemiol 2004;159(12):1140–1149
20. Salvadori A, Fanari P, Mazza P, Agosti R, Longhini E. Work capacity and cardiopulmonary adaptation of the obese subject during exercise testing. Chest 1992;101(3):674–679
21. Sakamoto S, Ishikawa K, Senda S, Nakajima S, Matsuo H. The effect of obesity on ventilatory response and anaerobic threshold during exercise. J Med Syst 1993;17(3–4):227–231
22. Kamoun S, Alves A, Bretagnol F, Lefevre JH, Valleur P, Panis Y. Outcomes of laparoscopic colorectal surgery in obese and nonobese patients: a case-matched study of 180 patients. Am J Surg 2009;198(3):450–455
23. Delaney CP, Pokala N, Senagore AJ, et al. Is laparoscopic colectomy applicable to patients with body mass index >30? A case-matched comparative study with open colectomy Dis Colon Rectum 2005;48(5):975–981
24. Pollard CW, Nivatvongs S, Rojanasakul A, Ilstrup DM. Carcinoma of the rectum. Profiles of intraoperative and early postoperative complications. Dis Colon Rectum 1994;37(9): 866–874
25. Lavie CJ, Milani RV, Ventura HO. Obesity and cardiovascular disease: risk factor, paradox, and impact of weight loss. J Am Coll Cardiol 2009;53(21):1925–1932
26. Coon WW. Risk factors in pulmonary embolism. Surg Gynecol Obstet 1976;143(3):385–390
27. Borow M, Goldson H. Postoperative venous thrombosis. Evaluation of five methods of treatment. Am J Surg 1981; 141(2):245–251
28. Pasulka PS, Bistrian BR, Benotti PN, Blackburn GL. The risks of surgery in obese patients. Ann Intern Med 1986; 104(4):540–546
29. Choban PS, Flancbaum L. The impact of obesity on surgical outcomes: a review. J Am Coll Surg 1997;185(6):593–603
30. Fleming FJ, Kim MJ, Salloum RM, Young KC, Monson JR. How much do we need to worry about venous thromboembolism after hospital discharge? A study of colorectal surgery patients using the National Surgical Quality Improvement Program database Dis Colon Rectum 2010;53(10):1355–1360
31. Senagore AJ, Delaney CP, Madboulay K, Brady KM, Fazio VW. Laparoscopic colectomy in obese and nonobese patients. J Gastrointest Surg 2003;7(5):712
32. Blee TH, Belzer GE, Lambert PJ. Obesity: is there an increase in perioperative complications in those undergoing elective colon and rectal resection for carcinoma? Am Surg 2002;68(2):163–166
33. Balentine CJ, Marshall C, Robinson C, et al. Obese patients benefit from minimally invasive colorectal cancer surgery. J Surg Res 2010;163(1):29–34
34. Pikarsky AJ, Saida Y, Yamaguchi T, et al. Is obesity a high-risk factor for laparoscopic colorectal surgery? Surg Endosc 2002;16(5):855–858
35. Khoury W, Stocchi L, Geisler D. Outcomes after laparoscopic intestinal resection in obese versus non-obese patients. Br J Surg 2011;98(2):293–298
36. Khoury W, Kiran RP, Jessie T, Geisler D, Remzi FH. Is the laparoscopic approach to colectomy safe for the morbidly obese? Surg Endosc 2010;24(6):1336–1340
37. Dean PA, Beart RW Jr, Nelson H, Elftmann TD, Schlinkert RT. Laparoscopic-assisted segmental colectomy: early Mayo clinic experience. May Clin Proc 1994 Sep;69(9):834–840
38. Kamoun S, Alves A, Bretagnol F, Lefevre JH, Valleur P, Panis Y. Outcomes of laparoscopic colorectal surgery in obese and nonobese patients: a case-matched study of 180 patients. Am J Surg 2009;198(3):450–455

39. Dostalík J, Martínek L, Vávra P, Andel P, Gunka I, Gunková P. Laparoscopic colorectal surgery in obese patients. Obes Surg 2005;15(9):1328–1331
40. Healy LA, Ryan AM, Sutton E, et al. Impact of obesity on surgical and oncological outcomes in the management of colorectal cancer. Int J Colorectal Dis 2010;25(11):1293–1299
41. Sarli L, Rollo A, Cecchini S, et al. Impact of obesity on laparoscopic-assisted left colectomy in different stages of the learning curve. Surg Laparosc Endosc Percutan Tech 2009; 19(2):114–117
42. Kiran RP, Remzi FH, Fazio VW, et al. Complications and functional results after ileoanal pouch formation in obese patients. J Gastrointest Surg 2008;12(4):668–674
43. Biondo S, Parés D, Kreisler E, et al. Anastomotic dehiscence after resection and primary anastomosis in left-sided colonic emergencies. Dis Colon Rectum 2005; 48(12):2272–2280
44. Pavlidis TE, Galatianos IN, Papaziogas BT, et al. Complete dehiscence of the abdominal wound and incriminating factors. Eur J Surg 2001;167(5):351–354; discussion 355
45. Rullier E, Laurent C, Garrelon JL, Michel P, Saric J, Parneix M. Risk factors for anastomotic leakage after resection of rectal cancer. Br J Surg 1998;85(3):355–358
46. Yahchouchy-Chouillard E, Aura T, Picone O, Etienne JC, Fingerhut A. Incisional hernias. I. Related risk factors. Dig Surg 2003;20(1):3–9
47. Sugerman HJ, Kellum JM Jr, Reines HD, DeMaria EJ, Newsome HH, Lowry JW. Greater risk of incisional hernia with morbidly obese than steroid-dependent patients and low recurrence with prefascial polypropylene mesh. Am J Surg 1996;171(1):80–84
48. Vidović D, Jurisić D, Franjić BD, Glavan E, Ledinsky M, Bekavac-Beslin M. Factors affecting recurrence after incisional hernia repair. Hernia 2006;10(4):322–325
49. Sauerland S, Korenkov M, Kleinen T, Arndt M, Paul A. Obesity is a risk factor for recurrence after incisional hernia repair. Hernia 2004;8(1):42–46
50. Londono-Schimmer EE, Leong AP, Phillips RK. Life table analysis of stomal complications following colostomy. Dis Colon Rectum 1994;37(9):916–920
51. Duchesne JC, Wang YZ, Weintraub SL, Boyle M, Hunt JP. Stoma complications: a multivariate analysis. Am Surg 2002;68(11):961–966; discussion 966
52. Leenen LP, Kuypers JH. Some factors influencing the outcome of stoma surgery. Dis Colon Rectum 1989;32(6):500–504
53. Arumugam PJ, Bevan L, Macdonald L, et al. A prospective audit of stomas—analysis of risk factors and complications and their management. Colorectal Dis 2003;5(1):49–52