# Impact of obesity on minimally invasive colorectal surgery: A comparative study and retrospective study

Original Article

*Mohammed E. Youssef, Ahmed A. Khalil and Tasnim R. Naeem*

*Department of General Surgery and Colorectal Surgery, Ain Shams University, Cairo, Egypt.*

## ABSTRACT

**Background:** Because of its many advantages, minimally invasive surgery, has emerged as the gold standard for treating colorectal disorders in the industrialized world. Obesity is a technological hurdle for minimally invasive colorectal resection surgery as it grows more common. Numerous research projects have looked at the clinical results of surgery in obese patients.

**Objective:** To evaluate the impact of obesity on minimally invasive colorectal surgery.

**Patients and Methods:** This retrospective comparative study was conducted at the Colorectal Unit, General Surgery Department, Ain Shams Hospitals on patients who underwent laparoscopic colorectal surgery for various diseases on an elective basis through the last 3 years. They were divided into two groups: control (nonobese) and study (obese) groups. We collected data on the patients from records in the colorectal unit. Patients' data were collected from perioperative records of each patient (intraoperative events, conversion rate, and complications). Cases were assessed as regards operative time, conversion rate, intraoperative events, chest problems from anesthesia due to $CO_2$ inflation to make pneumoperitoneum for the laparoscope, and early postoperative complications such as surgical-site infection, leakage, and hospital stay.

**Results:** As regards operative time, there was a statistically significant long time of operation time in the obese group in comparison to the nonobese group with a *P value* less than 0.001. As regards intraoperative events and conversion rate, the estimated blood loss was a bit higher in the obese group with no statistical significance. Five cases in the obese group were converted to open, while only one case in the nonobese group was converted to open. However, this was found statistically nonsignificant with a *P value* of 0.193. We had nine cases of surgical-site infection in the obese group versus two cases in the nonobese group.

**Conclusion:** We can conclude that obesity had an adverse impact on outcomes of minimally invasive colorectal surgeries.

**Key Words:** Laparoscopic colorectal surgery, minimally invasive surgery, obesity.

**Received:** 14 March 2024, **Accepted:** 25 March 2024, **Published:** 4 October 2024

**Corresponding Author:** Tasnim R. Naeem, MD, Department of General Surgery and Colorectal Surgery, Ain Shams University, Cairo, Egypt. **Tel.:** 01007982183, **E-mail:** tasnim.naeem@gmail.com

**ISSN:** 1110-1121, October 2024, Vol. 43, No. 4: 1146-1155, © The Egyptian Journal of Surgery

## INTRODUCTION

The benefits of minimally invasive surgery (MIS), which include a shorter hospital stay, reduced postoperative discomfort, early mobility, and enhanced cosmesis, have been well established. MIS has emerged as the new standard for treating colorectal illnesses in the developed world[1].

These advantages are especially important for high-risk patient populations, such as the clinically obese, whose presentation is correlated with multiple comorbidities, including diabetes mellitus, cardiovascular disease, and an increased risk of pulmonary emboli and surgical-site infections[2].

This leads one to hypothesize that a less intrusive surgical technique would be best for this particular patient population. Although obese individuals stand to benefit greatly from a minimally invasive approach to colorectal surgery, the extra visceral fat that these patients experience makes the procedure more technically challenging[3].

Patients who are obese frequently have thicker mesentery, which can cause problems with bleeding, distort the surgical planes, and impede access[4].

There is disagreement about whether the higher technical difficulties these patients experience result in lower immediate results and higher conversion rates[5].

Studies on the short-term results of obese patients undergoing laparoscopic colorectal surgery, for instance, have shown that while many of them report worse short-term outcomes, others show that the outcomes of obese and nonobese patients are similar[6].

*DOI: 10.21608/EJSUR.2024.276784.1026*

Obesity is on the rise due to an aging population, austerity, and lifestyle choices. This is posing health and care difficulties and driving up economic expenses. Since visceral fat in the abdomen further restricts the space for maneuvering during surgery and makes it difficult to define the surgical planes, the technical challenges discussed above for obese patients are magnified when considering MIS on morbidly obese patients, where the risks encountered in this group of patients are even greater. For this reason, we address the effects of obesity during the perioperative phase and minimally invasive operations in colorectal illnesses in our study.

### *Aim*

The study aims to evaluate the impact of obesity on minimally invasive colorectal surgery regarding operative time, conversion rate, intraoperative events, and early postoperative complications (surgical-site infection, leakage, and hospital stay).

## PATIENTS AND METHODS:

### *Type of study*

A retrospective study.

### *Study setting*

Colorectal Unit in the General Surgery Department, Ain Shams Hospitals.

### *Study population*

Patients who underwent laparoscopic colorectal surgery for various diseases on an elective basis through the last 3 years.

Patients were divided into two groups: control (nonobese) group and the obese group.

### *Selection criteria for cases*

### *Inclusion criteria*

Age: 18 years or more. Sex: both males and females were included. Obese: BMI more than or equal to 30. All types of electives colorectal surgery and any cause for colorectal surgery.

### *Exclusion criteria*

We excluded cases with preoperative cardiopulmonary compromise and emergency cases.

### *Sample size*

Using a clinical sample size calculator for an analytical study, the study's power was 0.80, 95% confidence interval (CI), and the alpha error was 0.05. Operation duration and blood loss varied across the three groups (morbidly obese vs. obese vs. nonobesity: 185 vs. 188 vs. 170 min, *P=0.000*; 20 vs. 20 vs. 10 ml, *P=0.003*), according to the literature. A sample size of 58 individuals was determined to detect the impact of obesity on minimally invasive colorectal surgery (29 patients are obese and 29 are not).

### *Sampling technique*

A convenient sample of patients with the inclusion and exclusion criteria was assigned to the study till reaching the total sample size calculated.

### *Study procedure*

We collected data of the patients from records in the colorectal unit. Operations were performed by the same surgical team. The obtained data included the following information about the patients: complete history taking: personal history, any complaint, past medical, and past surgical history. Complete physical examination: vital signs (blood pressure, temperature, heart rate, and respiratory rate), signs of (pallor, cyanosis, jaundice, and lymph node enlargement), measurements taken of height, weight, and hip and waist circumference. BMI for each patient. Type of minimally invasive colorectal surgery and patients' management performed following Ain Shams University local protocols. Patients' data from perioperative records of each patient (intraoperative events, conversion rate, and complication). Postoperative complications are defined as those occurring during hospitalization or within 30 days of surgery, including abdominal and extra-abdominal complications. Mortality was defined as death occurring in the hospital or within 30 days of surgery. Detection of leakage, conversion to open surgery due to technical difficulty of fat and infection of the wound used for specimen retrieval.

### *Main outcome measures*

Correlation between obesity and perioperative events.

### *Ethical considerations*

Approval of the ethics committee to retrieve data of the patients in the database of the Surgery Department was sought provided that the patient had not consented preoperatively to include his data in clinical study assuring patient privacy and dignity by not stating their identity.

### *Statistics data analysis*

Version 21 of SPSS (IBM, Chicago, USA) was used as data analysis software. Quantitative data was reported as mean, SD, median, and interquartile range; qualitative data were presented as numbers and percentages. Tests of significance, both parametric and nonparametric ($\chi^2$, Student's t test, and Mc Nemar test) tests were conducted. The threshold for significance was fixed at *P value* of 0.05 or less.

## RESULTS:

Tables 1-7 shows a comparison between obese and nonobese groups regarding clinicopathological data, perioperative events, and related complications. The obese group shows a higher rate of conversion, longer operative time, and an increase in postoperative surgical-site infection.

There is a statistically significant difference between the studied groups regarding BMI (which was significantly higher among the case group).

There is a statistically nonsignificant difference between the studied groups regarding sex, comorbidity, nature of the lesion, diagnosis, presence of metastasis among patients with cancer, or the type of operation.

There is a statistically significant difference between the studied groups regarding operative time and wound infection.

There is a statistically nonsignificant difference between the studied groups regarding either postoperative length of hospital stay, estimated blood loss, time to pass flatus, need to conversion to open, intraoperative, and other postoperative complications.

There is a statistically significant positive correlation between BMI and operative time. There is a statistically nonsignificant correlation between BMI and either estimated blood loss, time to pass flatus, or postoperative stay.

There is a statistically significant relation between complications and all of the operative time and the need to blood transfusion (all those who need blood transfusion were complicated).

There is a statistically nonsignificant difference between the studied groups regarding postoperative length of hospital stay, time to pass flatus, estimated blood loss, and conversion to open.

Increasing BMI and associated comorbidities independently increase the risk of complications by about 1.6, and 9.36, respectively.

There is a statistically significant relation between conversion to open and operative time (which was significantly higher among patients who need conversion).

There is a statistically nonsignificant relation between conversion to open and either postoperative length of hospital stay, time to pass flatus, blood transfusion, and estimated blood loss.

Increasing BMI and operative time significantly independently increase the risk of complications by about 1.44-fold and 2.2-fold, respectively (Figs 1-3).

**Table 1:** Comparison between the studied groups regarding clinicopathological data

| | Obese group (*N*=29) [*n* (%)] | Nonobese group (*N*=29) [*n* (%)] | $\chi^2$ | *P* |
|---|---|---|---|---|
| Sex | | | | |
| Female | 18 (62.1) | 11 (37.9) | 3.379 | 0.066 |
| Male | 11 (37.9) | 18 (62.1) | | |
| Age | 53.48±7.3 | 51.14±11.42 | 0.932 | 0.356 |
| BMI | 32.58±2.18 | 26.0±2.56 | 10.543 | <0.001** |
| Comorbidities | | | | |
| Absent | 21 (72.4) | 25 (86.2) | 1.681 | 0.195 |
| Present | 8 (27.6) | 4 (13.8) | | |
| Nature of lesion | | | | |
| Malignant | 27 (93.1) | 27 (93.1) | 0 | >0.999 |
| Benign | 2 (6.9) | 2 (6.9) | | |
| Diagnosis | | | | |
| Cancer colon | 4 (13.8) | 6 (20.7) | 10.067 | 0.215 |
| Colorectal cancer | 5 (17.2) | 3 (10.3) | | |
| Rectal cancer | 5 (17.2) | 3 (10.3) | | |
| Rectosigmoid cancer | 6 (20.7) | 6 (20.7) | | |
| Right colon cancer | 2 (6.9) | 6 (20.7) | | |
| Sigmoid cancer | 5 (17.2) | 1 (3.4) | | |
| Transverse colon cancer | 0 | 2 (6.9) | | |
| Diverticulosis | 1 (3.4) | 1 (3.4) | | |

| | | | | |
|---|---|---|---|---|
| Rectal prolapse | 0 | 1 (3.4) | | |
| Rectovaginal fistula | 1 (3.4) | 0 | | |
| Metastasis (malignant) | | | | |
| No metastasis | 25 (92.6) | 26 (96.3) | Fisher | >0.999 |
| Liver metastasis | 2 (7.4) | 1 (3.7) | | |
| Operation type | | | | |
| Lap extended hemicolectomy | 1 (3.4) | 1 (3.4) | 12.19 | 0.143 |
| Lap hemicolectomy | 2 (6.9) | 12 (41.4) | | |
| LAP AR with end colectomy | 1 (3.4) | 1 (3.4) | | |
| LAP AR | 11 (37.9) | 10 (34.5) | | |
| Lap colectomy | 3 (10.3) | 1 (3.4) | | |
| Lap exploration | 1 (3.4) | 0 | | |
| Lap AR with loop ileostomy | 4 (13.8) | 1 (3.4) | | |
| Lap sigmoidoscopy | 3 (10.3) | 2 (6.9) | | |
| Lap total colectomy | 3 (10.3) | 1 (3.4) | | |

**$P$ value* less than or equal to 0.001 is statistically highly significant with the $\chi^2$ test, independent sample t test.

**Table 2:** Comparison between the studied groups regarding operative and postoperative data

| | Obese group [median (IQR)] | Nonobese group [median (IQR)] | *Z* | *P* |
|---|---|---|---|---|
| Operative time (h) | 5 (4.25–6) | 4 (3–4.25) | –4.296 | <0.001** |
| Estimated blood loss (ml) | 350 (250–400) | 250 (200–350) | –1.611 | 0.107 |
| Time to pass flatus (day) | 2 (1–2) | 2 (1–2) | –1.039 | 0.299 |
| Postoperative stay (day) | 9 (7.5–10.5) | 8 (7–11) | –0.157 | 0.857 |
| Conversion to open [*n* (%)] | | | | |
| No | 24 (82.8) | 28 (96.5) | Fisher | 0.193 |
| Yes | 5 (17.2) | 1 (3.5) | | |
| Blood transfusion [*n* (%)] | | | | |
| No need | 27 (93.1) | 28 (96.6) | Fisher | >0.999 |
| Needed | 2 (6.9) | 1 (3.4) | | |
| Intraoperative complications [*n* (%)] | | | | |
| Vascular injury | 0 | 0 | 0 | >0.999 |
| Major serosal injury | 2 (6.9) | 0 | Fisher | 0.491 |
| Bladder injury | 1 (3.4) | 0 | Fisher | >0.999 |
| Postoperative complications [*n* (%)] | | | | |
| Anastomotic site leakage | 1 (3.4) | 0 | Fisher | >0.999 |
| Wound infection | 9 (31.0) | 2 (7.1) | Fisher | 0.041* |
| Paralytic ileus | 0 | 0 | 0 | >0.999 |
| Morbidity | 0 | 0 | 0 | >0.999 |
| Stoma complications | 1 (3.4) | 0 | Fisher | >0.999 |
| Resurgery | 0 | 0 | 0 | >0.999 |

IQR, interquartile range; t, independent sample t test; Z, Mann–Whitney test; $\chi^2$, $\chi^2$ test.
**$P$ value* less than or equal to 0.001 is statistically highly significant.
*$P$ value* less than 0.05 is statistically significant.

**Table 3:** Correlation between BMI and operative and postoperative data

| | *r* | *P* |
|---|---|---|
| Operative time (h) | 0.462 | <0.001** |
| Estimated blood loss (ml) | 0.142 | 0.287 |
| Time to pass flatus (days) | –0.075 | 0.576 |
| Postoperative stay (day) | –0.163 | 0.222 |

r, Spearman rank correlation coefficient.
***P value* less than or equal to 0.001 is statistically highly significant.

**Table 4:** Relation between complications and operative and postoperative data

| | Noncomplicated (mean±SD) | Complicated (mean±SD) | *t* | *P* |
|---|---|---|---|---|
| Operative time (h) | 4.16±1.17 | 6.2±1.62 | –4.658 | <0.001** |
| | Median (IQR) | Median (IQR) | *Z* | *P* |
| Estimated blood loss (ml) | 300 (212.5–350) | 350 (187.5–450) | –1.009 | 0.313 |
| Time to pass flatus (day) | 2 (1–2) | 2 (1–3) | –1.284 | 0.199 |
| Postoperative stay (day) | 9 (7–10) | 11 (6–15) | –0.821 | 0.411 |
| Conversion to open [*n* (%)] | | | | |
| No | 45 (93.8) | 7 (70) | Fisher | 0.057 |
| Yes | 3 (6.2) | 3 (30) | | |
| Blood transfusion [*n* (%)] | | | | |
| No need | 48 (100) | 7 (70) | Fisher | 0.004* |
| Needed | 0 | 3 (30) | | |

IQR, interquartile range; t, independent sample t test; Z, Mann–Whitney test; $\chi^2$, $\chi^2$ test.
***P value* less than or equal to 0.001 is statistically highly significant.
**P value* less than 0.05 is statistically significant.

**Table 5:** Binary regression analysis of factors associated with incidence of complications

| | **β** | *P* | AOR | 95% CI | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| BMI | 0.470 | 0.064 | 1.600 | 0.972 | 2.634 |
| Comorbidities | 2.236 | 0.071 | 9.354 | 0.823 | 106.364 |

AOR, adjusted odds ratio; CI, confidence interval.

**Table 6:** Relation between the need to conversion to open and operative and postoperative data

| | No conversion (mean±SD) | Conversion (mean±SD) | *t* | *P* |
|---|---|---|---|---|
| Operative time (h) | 4.33±1.36 | 6.0±1.67 | –2.78 | 0.007* |
| | Median (IQR) | Median (IQR) | *Z* | *P* |
| Estimated blood loss (ml) | 300 (212.5–350) | 350 (187.5–362.5) | –0.709 | 0.492 |
| Time to pass flatus (day) | 2 (1–2) | 2 (1–2.25) | –0.398 | 0.737 |
| Postoperative stay (day) | 9 (7–10.75) | 11 (7.75–15.5) | –1.277 | 0.212 |
| Blood transfusion [*n* (%)] | | | | |
| No need | 50 (96.2) | 5 (83.3) | Fisher | 0.284 |
| Needed | 2 (3.8) | 1 (16.7) | | |

IQR, interquartile range; t, independent sample t test; Z, Mann–Whitney test; $\chi^2$, $\chi^2$ test.
***P value* less than or equal to 0.001 is statistically highly significant.
**P value* less than 0.05 is statistically significant.

**Table 7:** Binary regression analysis of factors associated with conversion to open

| | β | *P* | AOR | 95% CI | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| BMI | 0.363 | 0.049* | 1.438 | 1.0 | 2.067 |
| Operative time | 0.789 | 0.041* | 2.2 | 1.031 | 4.695 |

AOR, adjusted odds ratio; CI, confidence interval.
**P value* less than 0.05 is statistically significant.

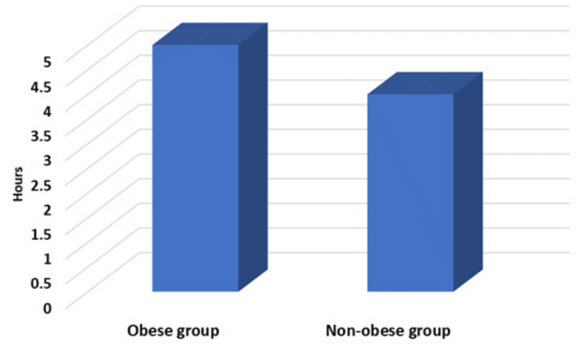


**Fig. 1:** Median operative time (hours) in the study groups.

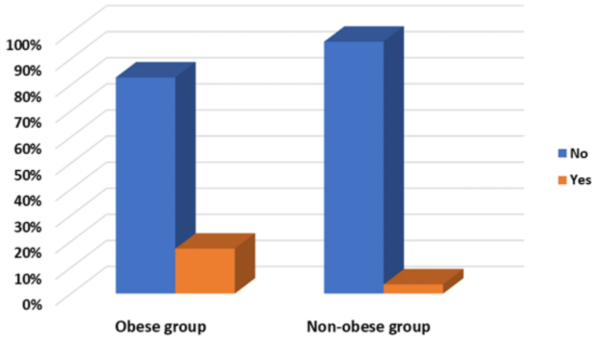


**Fig. 2:** Percentage of conversion to open in the study groups.

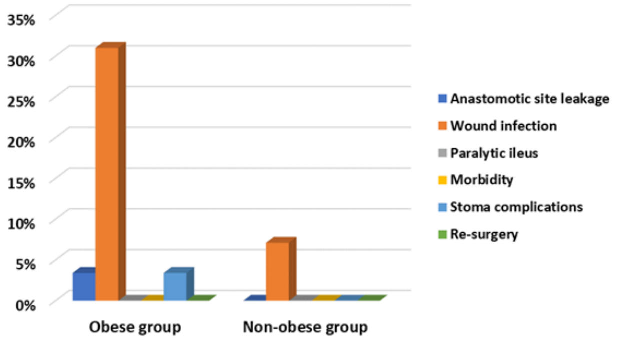


**Fig. 3:** Percentage of postoperative complications in the study groups.

## DISCUSSION

Patients who are obese are said to experience poorer intraoperative and postoperative results than nonobese patients. These outcomes include longer operating times, greater rates of surgical-site infection, higher rates of wound dehiscence, and higher risks of postoperative death[7].

The most common reasons for a colorectal resection – cancer, diverticulitis, and inflammatory bowel disease – are all more common in obese patients, and these conditions have been linked to higher costs and higher rates of conversion[8]. As a result, obesity has a significant impact on colorectal surgeons.

There is growing interest in determining whether the surgical approach can reduce some of the expected morbidity and worse outcomes of colorectal operations in obese patients due to the realization that MIS lowers postoperative pain, length of stay, surgical-site infections, and overall hospital costs[9].

It is difficult to ascertain retroactively whether obesity or surgical techniques (laparoscopy or robotics) have a greater influence on outcomes due to selection bias, which is impossible to eliminate even using statistical models. Nevertheless, knowing the 'dose-effect' of obesity on significant surgical outcomes allows for the drawing certain conclusions[10].

Thus, the purpose of this study was to assess the effect of obesity on minimally invasive colorectal surgery.

This retrospective comparative study was conducted at the Colorectal Unit, General Surgery Department, Ain Shams Hospitals on patients who underwent laparoscopic colorectal surgery for various diseases on an elective basis through the last 3 years. The patients were divided into two groups: control (nonobese) and study (obese) groups. We collected data on the patients from records in the colorectal unit. Patients' data were collected from perioperative records of each patient (intraoperative events, conversion rate, and complications). Cases were assessed as regards operative time, conversion rate, intraoperative events, chest problems from anesthesia due to $CO_2$ inflation to make pneumoperitoneum for the laparoscope, and early postoperative complications such as surgical-site infection, leakage, and hospital stay.

Most of the studies that disagreed with our results were due to several causes such as different study methodologies, outcomes, sample size, and different medical conditions of studied cases at the time of enrollment.

As regards operative time, there was a statistically significant long time of operation in the obese group, which was 5±0.75 h in comparison to the nonobese group which was 4±0.75 h with *P value* less than 0.001.

Suwa *et al*.[11] agreed with us and reported that colorectal surgery in obese patients results in a significantly longer duration of surgery. A longer duration of surgery was documented in obese compared with nonobese patients. Twelve of the 131 full-text publications that were assessed fulfilled the inclusion requirements and were included in the analysis. There were 1420 obese individuals and 3166 nonobese patients. Compared with patients who were not obese, obese patients had surgeries that took longer to complete. Compared with nonobese patients, people who were obese had a greater conversion rate to laparotomy.

A similar tendency in obese patients receiving laparoscopic surgery is consistent with the discovery of lengthier operating durations in these patients undergoing colorectal surgery[5,6,12]. The requirement for multiple changes of position in obese individuals during surgery, the increased need for the number of port access, anesthesia, and the specifics of the patient's surgical setup might all contribute to the prolonged surgical times observed in these patients.

As regards intraoperative events and conversion rate, the estimated blood loss was a bit higher in the obese group but with no statistical significance [the obese group was 350 ml (250–400) vs. nonobese 250 ml (200–350) with a *P=0.107*].

Intraoperative complications: there were no cases of vascular injury in either groups and two cases of serosal injury in the obese group and one case of urinary bladder injury in the obese group with no cases of serosal or bladder injury in the nonobese group. This was found statistically nonsignificant and our explanation for those cases with injuries is the heavily loaded colon with fat and fatty bulky mesentery which render the handling of the tissues more difficult and traction more injurious.

In the obese group, there were two instances requiring blood transfusions, while there was just one case in the nonobese group that did not reach statistical significance.

Regarding conversion to open, five cases in the obese group were converted to open, while only one case in the nonobese group was converted to open. However, this was found statistically nonsignificant with a *P value* of 0.193.

The cause of conversion varied between technical difficulties due to fatty mesentery and heavy colon that was difficult to handle and dissect. There were three cases of injuries (serosal and bladder injury) and one case because of the length of the operation and the resulting compromise of the cardiopulmonary situation of the patient as stated by anesthesia due to prolonged insufflation.

Our explanation for the nonsignificance of the results despite the big difference in five versus one case is the limited number of study population, which in our opinion is the number of cases enrolled in larger studies and the differences will show more significance.

After looking through the literature, we discovered that several studies – Stevenson *et al*.[13], Fleshman *et al*.[14], and Bonjer *et al*.[15] – reported that the overall conversion rate in laparoscopic colorectal surgery was as high as 29%.

According to Makino *et al*.[16], conversion rates following minimally invasive colorectal surgery have consistently been greater in obese individuals than in nonobese patients.

Our results align with a recent meta-analysis by He *et al*.[6] comparing the outcomes of obese with nonobese individuals following laparoscopic colorectal surgery. The obese group had increased operational time and blood loss.

The current study's conversion rates are comparable to those discovered in a previous systematic analysis by Fung *et al*.[5] comparing patients undergoing laparoscopic colorectal surgery who were obese versus nonobese. The meta-analysis contained 13 observational studies totaling 4550 patients. The obese group had substantially higher rates of conversion [odds ratio (OR)=2.11, 95% CI=1.58–2.81), postoperative morbidity (OR=1.54, 95% CI=1.21–1.97), wound infection (OR=2.43, 95% CI=1.46–4.03), and anastomotic leak (OR=1.65, 95% CI=1.01–2.71).

The incremental influence of BMI on the morbidity and outcomes of colorectal surgeries, as well as whether laparoscopic and robotic (MIS) techniques ameliorate this morbidity differentially, was discussed by Unruh *et al*.[17]. A retrospective cohort of patients in SCOAP who were having elective colorectal surgeries was established to investigate the impact of rising BMI on surgical outcomes. It was found in this study that increasing BMI is associated with increased conversion and operative time. Even with MIS, increasing BMI is associated with worse surgical outcomes. However, in obese patients, robotics is associated with lower conversion and better outcomes.

In a study discussing the effect of obesity on conversion rates and perioperative morbidities, Panteleimonitis *et al*.[18] disagreed with our study stating that the increased technical difficulty found in obese and morbidly obese patients in minimally invasive colorectal surgery results in increased operative times and blood loss, though this was found not clinically significant. However, conversion rate and postoperative short-term outcomes are similar between morbidly obese, obese, and nonobese patients.

As regards postoperative events, in our study we had one case of anastomotic site leakage in comparison to no cases in the nonobese group. This case was managed conservatively with complete resolution of the leak.

We had nine cases of SSI in the obese group versus two cases in the nonobese group, which was statistically significant with a *P value* of 0.041.

There was only one case in our study with stoma complications in the form of dehiscence in the obese group out of seven cases of stomas in this study between obese and nonobese groups and was not found to be statistically significant.

There are statistically nonsignificant differences between the studied groups regarding either postoperative length of hospital stay, time to pass flatus, other morbidities, paralytic ileus, or the need for resurgery.

After searching the literature, we discovered that, according to Wahl *et al*. 2018[19], obese individuals having laparoscopic colorectal surgery often have more postoperative problems than nonobese patients, including anastomotic leak, surgical-site infection, or wound problems, as also stated by Akiyoshi *et al*.[20]. In Watanabe *et al*.[21], Schootman *et al*.[22], and He *et al*.[6] ileus following surgery and urinary complications was found to be more in obese individuals. According to Lin *et al*.[22], these might be brought on by the underlying comorbidity of obesity, which also includes diabetes mellitus, heart disease, and sleep apnea.

Anastomotic leak is possibly the most dreaded postoperative surgical complication due to the high rates of morbidity and death that are linked with it, according to Xia *et al*.[24].

Numerous investigations have shown that obesity is an independent risk factor for anastomotic leakage in all colorectal surgeries, as well as in rectal surgery alone, as described by Qiu *et al*.[25] and Yamamoto *et al*.[25]. This has been shown by Akiyoshi *et al*.[20] and Senagore *et al*.[27]. This has been historically explained by a variety of variables, including inadequate local tissue perfusion, comorbidities associated with obesity, such as type 2 diabetes mellitus and its accompanying arteriopathy, and higher intraoperative technical difficulties in obese patients.

The comparable rates of anastomotic leakage observed in our study between obese and nonobese patients could be attributed to improved intraoperative technical capability, which ensures adequate perfusion of both ends before initiating the anastomosis, as well as the relatively small number of cases compared with other studies, which might reveal higher numbers with statistically significant differences if a larger population was studied.

Numerous prior investigations, including systematic reviews and meta-analyses, have demonstrated a correlation between obesity and elevated conversion rates, anastomotic leak rates, heightened postoperative morbidity, and reduced lymph node yield in the context of MIS[5,6,28,29].

Nonetheless, comparable short-term surgical results have been documented in several studies including obese and nonobese patients[4,30].

A published American study by Champagne *et al*.[31] found that the results of obese patients receiving laparoscopic colectomies varied according to how severe their obesity was. The outcomes of three patient groups with obesity – obese, morbidly obese, and super-obesity – were evaluated in this study. This study found a correlation between rising obesity severity and worse perioperative outcomes.

The only group in which these short-term outcomes deteriorate is the super-obesity group (BMI>50). Between the obese and severely obese groups, the remaining short-term results (operative time, conversion rate, postsurgical morbidity, and length of stay) are comparable. The super-obese group's considerably larger abdominal wall thickness and visceral adiposity may have exacerbated the technical difficulties of the procedure and led to the group's worse short-term outcomes.

Last but not least, Suwa *et al*.[11] reported that while the operative time and conversion rate showed statistical significance, the length of hospital stay, blood loss, surgical complications, and pathology results did not show significant differences between patients with and without obesity.

## CONCLUSION

We can conclude that obesity had an adverse impact on outcomes of minimally invasive colorectal surgeries. Obese cases had prolonged operative time, higher probability of conversion rate, and higher frequency of postoperative complications such as surgical-site infection, leakage, and other general complications. Increased BMI had no impact on operative events and postoperative stay.

## CONFLICT OF INTEREST

There is no conflict of interest.

## REFERENCES


1. . Salem JF, Gummadi S, Marks JH. Minimally invasive surgical approaches to colon cancer. Surg Oncol Clin 2018; 27:303–318.
2. Pugliese R, Regondi S. Artificial intelligence-empowered 3D and 4D printing technologies toward smarter biomedical materials and approaches. Polymers 2022; 14:2794.
3. Nugent AC, Andonegui AB, Holroyd T, Robinson SE. On-scalp magnetocorticography with optically pumped magnetometers: simulated performance in resolving simultaneous sources. Neuroimage Rep 2022; 2:100093.
4. Harr JN, Luka S, Kankaria A, Juo YY, Agarwal S, Obias V. Robotic-assisted colorectal surgery in obese patients: a case-matched series. Surg Endosc 2017; 31:2813–2819.
5. Fung A, Trabulsi N, Morris M, Garfinkle R, Saleem A, Wexner SD, *et al*. Laparoscopic colorectal cancer resections in the obese: a systematic review. Surg Endosc 2017; 31:2072–2088.
6. He Y, Wang J, Bian H, Deng X, Wang Z. BMI as a predictor for perioperative outcome of laparoscopic colorectal surgery: a pooled analysis of comparative studies. Dis Colon Rectum 2017; 60:433–445.
7. Phan HD, Nguyen TN, Bui PL, Pham TT, Doan TV, Nguyen DT, Van Minh H. Overweight and obesity among Vietnamese school-aged children: National prevalence estimates based on the World Health Organization and International Obesity Task Force definition. PloS one 2020; 15:e0240459.
8. McKechnie T, Wang J, Springer JE, Gross PL, Forbes S, Eskicioglu C. Extended thromboprophylaxis following colorectal surgery in patients with inflammatory bowel disease: a comprehensive systematic clinical review. Colorect Dis 2020; 22:663–678.
9. Yang W, Yuan T, Cai Z, Ma Q, Liu X, Zhou H, *et al*. Laparoscopic versus ultrasound-guided transversus abdominis plane block for postoperative pain management in minimally invasive colorectal surgery: a meta-analysis protocol. Front Oncol 2023; 13:1080327.
10. Greco F, Autorino R, Altieri V, Campbell S, Ficarra V, Gill I, *et al*. Ischemia techniques in nephron-sparing surgery: a systematic review and meta-analysis of surgical, oncological, and functional outcomes. Eur Urol 2019; 75:477–491.
11. Suwa Y, Joshi M, Poynter L, Endo I, Ashrafian H, Darzi A. Obese patients and robotic colorectal surgery: systematic review and meta-analysis. BJS Open 2020; 4:1042–1053.
12. Zhou Y, Wu L, Li X, Wu X, Li B. Outcome of laparoscopic colorectal surgery in obese and nonobese patients: a meta-analysis. Surg Endosc 2012; 26:783–789.
13. Stevenson AR, Solomon MJ, Lumley JW, Hewett P, Clouston AD, Gebski VJ, *et al*., ALaCaRT Investigators. Effect of laparoscopic-assisted resection vs open resection on pathological outcomes in rectal cancer: the ALaCaRT randomized clinical trial. JAMA 2015; 314:1356–1363.
14. Fleshman J, Branda M, Sargent DJ, Boller AM, George V, Abbas M, *et al*. Effect of laparoscopic-assisted resection vs open resection of stage II or III rectal cancer on pathologic outcomes: the ACOSOG Z6051 randomized clinical trial. JAMA 2015; 314:1346–1355.
15. Bonjer HJ, Deijen CL, Abis GA, Cuesta MA, Van Der Pas MH, De Lange-De Klerk ES, *et al*. A randomized trial of laparoscopic versus open surgery for rectal cancer. New Engl J Med 2015; 372:1324–1332.
16. Makino T, Shukla PJ, Rubino F, Milsom JW. The impact of obesity on perioperative outcomes after laparoscopic colorectal resection. Ann Surg 2012; 255:228–236.

17. Unruh KR, Bastawrous AL, Kaplan JA, Moonka R, Rashidi L, Simianu VV. The impact of obesity on minimally invasive colorectal surgery: a report from the Surgical Care Outcomes Assessment Program collaborative. Am J Surg 2021; 221:1211–1220.

18. Panteleimonitis S, Popeskou S, Harper M, Kandala N, Figueiredo N, Qureshi T, Parvaiz A. Minimally invasive colorectal surgery in the morbid obese: does size really matter?. Surg Endosc 2018; 32:3486–3494.

19. Wahl TS, Patel FC, Goss LE, Chu DI, Grams J, Morris MS. The Obese Colorectal Surgery Patient: Surgical Site Infection and Outcomes. Dis Colon Rectum. 2018 Aug;61(8):938-945.

20. Akiyoshi T, Ueno M, Fukunaga Y, Nagayama S, Fujimoto Y, Konishi T, *et al*. Effect of body mass index on short-term outcomes of patients undergoing laparoscopic resection for colorectal cancer: a single institution experience in Japan. Surg Laparosc Endosc Percutan Techniq 2011; 21:409–414.

21. Watanabe J, Tatsumi K, Ota M, Suwa Y, Suzuki S, Watanabe A, *et al*. The impact of visceral obesity on surgical outcomes of laparoscopic surgery for colon cancer. Int J Colorect Dis 2014; 29:343–351.

22. Schootman M, Hendren S, Loux T, Ratnapradipa K, Eberth JM, Davidson NO. Differences in effectiveness and use of robotic surgery in patients undergoing minimally invasive colectomy. J Gastrointest Surg 2017; 21:1296–1303.

23. Lin X, Li J, Chen W, Wei F, Ying M, Wei W, Xie X. Diabetes and risk of anastomotic leakage after gastrointestinal surgery. J Surg Res 2015; 196:294–301.

24. Xia X, Huang C, Jiang T, Cen G, Cao J, Huang K, Qiu Z. Is laparoscopic colorectal cancer surgery associated with an increased risk in obese patients? A retrospective study from China. World J Surg Oncol 2014; 12:1–7.

25. Qiu Y, Liu Q, Chen G, Wang W, Peng K, Xiao W, Yang H. Outcome of rectal cancer surgery in obese and nonobese patients: a meta-analysis. World J Surg Oncol 2015; 14:1–7.

26. Yamamoto S, Fujita S, Akasu T, Inada R, Moriya Y. Risk factors for anastomotic leakage after laparoscopic surgery for rectal cancer using a stapling technique. Surg Laparosc Endosc Percut Techniq 2012; 22:239–243.

27. Senagore AJ, Delaney CP, Madboulay K, Brady KM, Fazio CV. Laparoscopic colectomy in obese and nonobese patients. J Gastrointest Surg 2003; 7:558–561.

28. Yang T, Wei M, He Y, Deng X, Wang Z. Impact of visceral obesity on outcomes of laparoscopic colorectal surgery: a meta-analysis. ANZ J Surg 2015; 85:507–513.

29. Hussan H, Gray DM, Hinton A, Krishna SG, Conwell DL, Stanich PP. Morbid obesity is associated with increased mortality, surgical complications, and incremental health care utilization in the peri-operative period of colorectal cancer surgery. World J Surg 2016; 40:987–994.

30. Khoury W, Kiran RP, Jessie T, Geisler D, Remzi FH. Is the laparoscopic approach to colectomy safe for the morbidly obese?. Surg Endosc 2010; 24:1336–1340.

31. Champagne BJ, Nishtala M, Brady JT, Crawshaw BP, Franklin ME, Delaney CP, Steele SR. Laparoscopic colectomy in the obese, morbidly obese, and super morbidly obese: when does weight matter?. Int J Colorect Dis 2017; 32:1447–1451.