

## Prospective Study

# Obese patients have similar short-term outcomes to non-obese in laparoscopic colorectal surgery

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## Abstract

**AIM:** To determine whether obese patients undergoing laparoscopic surgery within an enhanced recovery program had worse short-term outcomes.

**METHODS:** A prospective study of consecutive patients undergoing laparoscopic colorectal resection was carried out between 2008 and 2011 in a single institution. Patients were divided in groups based on body mass index (BMI). Short-term outcomes including operative data, length of stay, complications and readmission rates were recorded and compared between the groups. Continuous data were analysed using *t*-test or one-way Analysis of Variance.  $\chi^2$  test was used to compare categorical data.

**RESULTS:** Two hundred and fifty four patients were included over the study period. The majority of individuals (41.7%) recruited were of a healthy weight (BMI < 25), whilst 50 patients were classified as obese (19.6%). Patients were matched in terms of the presence of co-morbidities and previous abdominal surgery. Obese patients were found to have a statistically significant difference in The American Society of Anesthesiologists grade. Length of surgery and intra-operative blood loss were no different according to BMI.

**CONCLUSION:** Obesity (BMI > 25) does not lead to worse short-term outcomes in laparoscopic colorectal surgery and therefore such patients should not be precluded from laparoscopic surgery.

**Key words:** Laparoscopic surgery; Colorectal cancer; Obese; body mass index; Outcomes

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**Core tip:** Laparoscopic colorectal surgery for cancer

can be safely performed in obese patients without an increase in adverse events or outcomes. Patients should not be precluded from laparoscopy in such cases based on their body mass index. However it is important for the team to assess patients pre-operatively to decide on whether additional or more intensive peri-operative care is needed to ensure optimal outcomes.

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## INTRODUCTION

Obesity is a considerable and growing healthcare concern, and more patients treated for colorectal cancer are obese with a body mass index (BMI) of greater than 30. Historically, individuals with an increased BMI have been thought of as having a higher risk of poorer outcomes following surgery with an increased rate of peri-operative complications and longer hospital stays, however more recent studies have challenged this view<sup>[1-3]</sup>.

The surgical management of colorectal cancer has shifted towards a minimally-invasive approach and the current expectation is that the majority of patients should undergo laparoscopic surgery. It is now recognised as a safe and more advantageous alternative to laparotomy for most patients as benefits include reduced morbidity and shorter hospital stays with comparable oncological outcomes to open surgery<sup>[4-7]</sup>.

However, obesity has long been considered a relative contraindication to laparoscopic surgery due to the perceived associated technical difficulty and increased morbidity<sup>[8-10]</sup>. Despite more recent reports of good short-term outcomes in colorectal cancer resections<sup>[11-13]</sup>, there remains a reluctance to offer laparoscopic surgery to obese patients. Consequently, an increasing number of patients with a high BMI are being denied the benefits of laparoscopic surgery.

The aim of this study was to determine whether obesity was an acceptable contraindication to laparoscopic colorectal surgery by comparing the short-term outcomes of patients with an increased BMI to those of a healthy weight-to-height ratio.

## MATERIALS AND METHODS

### Study design and setting

A prospective cohort study conducted between 2008 and 2011 at a single colorectal surgery institution in the United Kingdom.

### Study population

All consecutive patients undergoing laparoscopic colorectal surgery were included. There were no exclusion criteria. Consistent with the surgical protocol of the unit, all individuals were enrolled into its enhanced recovery after surgery (ERAS) program. A standardised approach to both the anaesthetic and the surgery was performed in all patients.

### Data collection

Data were collected prospectively on each individual patient and recorded anonymously on a database. These included patient demographics and BMI, The American Society of Anesthesiologists (ASA) grade, nature of surgery, operative and anaesthetic time, stoma formation, intra-operative blood loss, complications including anastomotic leak, unplanned high dependency unit (HDU) admission, length of hospital stay and readmission rates. Complications were recorded according to the Clavien-Dindo classification system.

### The ERAS protocol

All patients were counselled by a nurse specialist prior to surgery and given a detailed explanation of what to expect throughout the course of their hospital stay. Each patient was given contact details for a member of the ERAS team.

Patients were admitted on the day of surgery. The evening before admission each patient received a 100 g of Pre-Load (96 g of carbohydrate; osmolality of 285 mOsm) mixed in 400 mL of water. On the morning of admission, a further 50 g of Pre-Load in 400 mL of water was given 2 h before surgery. Following discharge, a dedicated nurse practitioner telephoned the patients at 48 h to enquire about any concerns. Patients were followed up in the out-patient department at 6 wk regardless of any concurrent oncological referral.

### Peri-operative anaesthetic regime

A standardised anaesthetic protocol was used for all patients. This consisted of a spinal anaesthetic before induction using 2 mL 0.5% plain bupivacaine with 700 mcg of diamorphine. Routine doses of propofol and remifentanyl were used for induction and atracurium for neuromuscular blockade. Intraoperative medication included 6.6 mg of dexamethasone, 4 mg of ondansetron, 1.5 g cefuroxime and 500 mg metronidazole. In addition to the intrathecal diamorphine, perioperative analgesia included 1 g IV paracetamol and 75 mg IV diclofenac. An orogastric tube and urinary catheter were sited with the former removed at the end of the procedure. Routine maintenance fluids during the procedure consisted of 1.5 L Hartmann's solution. Temperature was maintained using a Bair Hugger® blanket. Post-operative fluid regime included 1 L Hartmann's solution given over 10 h in addition to oral fluids and high calorie drinks. All patients were given oral paracetamol 1 g QD and Ibuprofen 400 mg TD.

**Table 1 Patient characteristics *n* (%)**

	All	BMI < 25	BMI 26-30	BMI > 30	<i>P</i> value
Number	254	106 (41.7)	98 (38.6)	50 (19.7)	< 0.001
Males	122 (48)	41 (38.7)	58 (59.2)	23 (46)	0.01
BMI	26 (23-30)	22.5 (2.1)	27.8 (1.5)	35.3 (5.9)	< 0.001
ASA grade	2 (0.6)	1.9 (0.6)	2.0 (0.6)	2.2 (0.6)	0.04
Previous abdominal surgery	80 (31.5)	34 (32)	30 (30.6)	16 (32)	0.972
Co-morbidities	187 (73.6)	76 (71.7)	75 (76.5)	36 (72)	0.789

Data presented as mean (standard deviation) unless otherwise indicated. Comparisons are between the three BMI groups. BMI: Body mass index; ASA: American Society of Anesthesiologists.

Patients were managed on an elective surgical ward and allowed oral fluids on the night of surgery. The urinary catheter was removed on the first operative day and patients were encouraged to take a solid oral diet and to mobilise.

### **Surgical technique**

All surgical procedures were carried out using a standardised modular technique. Patients were placed in the modified Lloyd-Davies position for all resections with the legs in stirrups but with the femurs horizontal to the floor, the arms positioned by the sides and high-friction gel pads were used. Arm boards and shoulder supports were avoided. Routine port positions were used for left and right-sided procedures with the use of a 10 mm 30 degree camera. Dissection was predominantly performed using the "hook" with diathermy attached and occasional use of an energy device. Specimens were extracted through a wound protector device using either lower right- or left-sided transverse muscle splitting incisions for right and left-sided resections, respectively. Extraction sites were closed in layers making sure to avoid muscle in the suture line and infiltrated with maximal safe dosage of bupivacaine 0.375%. For left-sided resections a leak test was performed with a flexible sigmoidoscope which was also used to inspect the anastomosis, but was not passed through it.

### **Statistical analysis**

Individuals were classified according to their BMI as healthy weight (< 25), overweight (26-30) and obese (> 30). Outcomes were compared between the three groups.

Continuous data are expressed as mean with standard deviation and categorical data as an absolute number and percentage. Continuous data were analysed using Analysis of Variance (ANOVA). Fisher's exact test or  $\chi^2$  test was used to compare categorical data. A two-sided *P* value of less than 0.05 was considered significant. All data analyses were performed using SPSS version 21 (SPSS Inc., Chicago IL).

## **RESULTS**

Two hundred and fifty four patients were included over

the study period. The majority of individuals (41.7%) recruited were of a healthy weight (BMI < 25), whilst 50 patients were classified as obese (19.6%). In all groups, there were more female patients than males. Overall, patients were well matched in terms of the presence of co-morbidities and previous abdominal surgery. Obese patients were found to have a statistically significant difference in ASA grade. Patient characteristics are shown in Table 1.

Anterior resection and right hemicolectomy were the two most frequently performed operations, accounting together for three quarters of the procedures undertaken (Table 2). There were no significant differences in the incidence and nature of operations across the BMI cohorts.

There were few significant differences in outcomes between obese patients and healthier weight individuals (Table 3). Only readmission rates with rectal bleeding were higher in the obese (2 patients in the obese group compared with none in the other groups), whilst there was a non-significant trend towards increasing anaesthetic time and length of stay associated with higher BMI. Unplanned HDU admission rates favoured patients with a higher BMI, whilst the rate of stoma formation was lower although not significant. Length of surgery and intra-operative blood loss were no different according to BMI.

## **DISCUSSION**

This study revealed that obese patients with an increased BMI have comparable short-term outcomes to healthy weight individuals. Furthermore, outcomes of overweight patients with a BMI of between 26 and 30 were also similar. In particular, there was no significant increase in post-operative complications or length of stay, both of which are historically associated with obese patients. Additionally, the length of operating time and intra-operative blood loss were similar in all groups, suggesting a comparable degree of operative difficulty. Finally of note, all patients in the study underwent an ERAS protocol with no adverse outcomes as a result of this approach, in spite of the traditional caution in patients with an increased BMI.

The relationship between obesity and various conditions has been clearly established including with type

**Table 2 Nature and number of operations**

Operation	Total	BMI < 25	BMI 26-30	BMI > 30	P value
Anterior resection	107 (42.1)	46 (43.4)	37 (37.8)	24 (48)	0.462
Right hemicolectomy	82 (32.3)	32 (30.2)	34 (34.7)	16 (32)	0.789
Left hemicolectomy	7 (2.8)	3 (2.8)	2 (2.1)	2 (2)	0.787
Ileocaecal resection	10 (3.9)	5 (4.7)	5 (5.1)	0 (0)	0.277
Panproctocolectomy	7 (2.8)	5 (4.7)	2 (2.1)	0 (0)	0.209
Abdominoperineal resection	2 (0.8)	0 (0)	2 (2.1)	0 (0)	0.201
Sigmoid colectomy	5 (2)	1 (0.9)	3 (3.1)	1 (2)	0.553
Subtotal/total colectomy	11 (4.4)	6 (5.7)	3 (3.1)	2 (4)	0.426
Hartmann's	3 (1.2)	1 (0.9)	2 (2.1)	0 (0)	0.530
Miscellaneous	20 (7.9)	7 (6.6)	8 (8.2)	5 (10)	0.756

Data presented as absolute number (percentage). Comparisons are between the three BMI groups. BMI: Body mass index.

**Table 3 Outcomes split by body mass index**

	BMI < 25	BMI 26-30	BMI > 30	P value
Anaesthetic time, min mean (SD)	41.10 (50.9)	52.62 (62.6)	67.55 (70.9)	0.080
Length of surgery, min mean (SD)	181.1 (65.4)	177.8 (56.6)	192.63 (61.5)	0.421
Intra-op blood loss, mL mean (SD)	33.18 (31.9)	44.00 (67.1)	38.33 (33.6)	0.309
Stoma	22 (20.8)	22 (22.5)	8 (16)	0.600
LOS, d, mean (SD)	4.1 (4.1)	3.9 (3.9)	5.8 (7.7)	0.076
All complications	23 (21.7)	15 (15.3)	14 (28)	0.686
Anastomotic leak	2 (1.9)	0 (0)	1 (2)	0.771
Re-admission	8 (7.5)	12 (12.2)	3 (6)	0.984
Wound infection	1 (0.9)	1 (1)	1 (2)	0.609
Abdominal collection	1 (0.9)	5 (5.1)	0 (0)	0.859
PR bleeding	0 (0)	0 (0)	2 (4)	0.021
DVT/PE	0 (0)	1 (1)	0 (0)	0.769
Obstruction/ileus	3 (2.8)	2 (2)	0 (0)	0.254
Vomiting/diarrhoea	3 (2.8)	1 (1)	0 (0)	0.156
Non-specific abdo pain	0 (0)	2 (2)	0 (0)	0.677

Data are presented as absolute number (percentage) unless otherwise indicated. LOS: Length of stay; BMI: Body mass index.

2 diabetes, cardiovascular disease, cerebrovascular disease, pulmonary disease, and more recently, cancer<sup>[14-17]</sup>. Therefore, it would be expected that more perioperative complications would be likely in the obese population consistent with associated comorbidities. It has been well documented that wound complications are significantly more common in obese patients following, in particular, those receiving long midline incisions<sup>[18-20]</sup>. Given that this may be the case, it is even more important in this group of patients to limit the surgical stress, so it is felt that they may actually be better off undergoing laparoscopic rather than open surgery. The relationship between obesity and laparoscopic colorectal surgery has evolved over the years. Initial reports investigating the feasibility of laparoscopy in patients with an increased BMI resulted in worse outcomes compared to the non-obese. This included more post-operative complications, conversions to open procedures and an increased length of stay. In cases of cancer resections, however, this was shown to be oncologically safe. Nonetheless, as techniques have improved and there is greater familiarity and capability

with laparoscopic surgery, short-term outcomes have become more comparable to open surgery<sup>[21-23]</sup>. Yet there remains a reluctance to offer laparoscopy to obese patients. It is important to recognise that open surgery in obese patients also takes longer and is more difficult.

Technically, the surgery can be demanding and has been shown repeatedly to lead to a higher learning curve<sup>[9]</sup>. A thicker, heavier mesentery creates difficulty in recognising the planes of dissection and causes limited space to operate within the abdomen. In those series which show comparable operating times and peri-operative outcomes such as blood loss, improved technology in the form of instruments and high-definition laparoscopes have been cited as factors. Classically, the obese male patient with a narrow pelvis has been considered the most challenging of surgery for colorectal surgeons.

The present study has shown that despite increased BMI, the intra-operative outcomes of blood loss and operating time are no different to non-obese patients. Previous reports have shown an increased operating time in obese patients which is most likely a reflection



of the difficulty in operating in these patients<sup>[10]</sup>. Interestingly, studies which showed an increase in the number of complications in obese patients also reported an increased length of stay. However, these two outcomes are intrinsically linked. For example, ileus is the most common cause of prolonged hospital admission after colorectal surgery<sup>[24]</sup>. This can be attributed to longer operating time and post-operative complications which need resolution prior to discharge. Therefore, it is not surprising that if the number of complications is reduced, so is the length of stay.

The rate of stoma formation was similar across groups. Stomas may often be formed to protect an anastomosis which is at risk of leaking, a concern associated with technically challenging surgery. It must be noted that stoma formation is also technically more challenging in obese patients due to the increased distance from the abdominal cavity to the skin.

The peri-operative approaches to laparoscopic cases in our institution are identical regardless of whether the resection is right or left-sided. This includes anaesthesia, patient preparation and positioning, and post-operative care. Clearly, there will be modifications in the port positioning although for the vast majority of cases no more than 4 ports and a transverse incision extraction site are used. Using a standardised approach allows clarity for all staff involved in the peri-operative care of the patient.

This study has shown that using a standardised peri-operative protocol including anaesthesia and surgical technique, obese patients can safely be offered laparoscopic surgery for colorectal cancer resections. The short-term outcomes including post-operative complications and length of stay are comparable to non-obese patients. Consequently, obesity should not preclude laparoscopic surgery being offered to patients for colorectal cancer.

## COMMENTS

### Background

An increased body mass index (BMI) has been traditionally associated with a higher rate of complications. Initial reports on laparoscopy stated the increased BMI should be a preclusion for laparoscopic approaches in colorectal cancer surgery. However as techniques have improved and become more standardised it is possible to safely operate on patients with a high BMI.

### Research frontiers

There is still some contention as to whether laparoscopic surgery can be safely performed for colorectal cancer without compromising oncological outcomes.

### Innovations and breakthroughs

This study demonstrates that patients can undertake laparoscopy without additional complications and similar short-term outcomes as non-obese patients.

### Applications

This study should allow clinicians to assess patients with a high BMI confidently and not preclude them from laparoscopy based solely on BMI.

## Peer-review

The study is clear, well-written and easy to read.

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