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BRIEF ARTICLE

Short and long-term outcomes of laparoscopic colectomy in obese patients

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Abstract

AIM: To investigate the impact of laparoscopic colectomy on short and long-term outcomes in obese patients with colorectal diseases.

METHODS: A total of 98 obese (body mass index > 30 kg/m^2) patients who underwent laparoscopic (LPS) right or left colectomy over a 10 year period were identified from a prospective institutionally approved database and manually matched to obese patients who underwent open colectomy. Controls were selected to match for body mass index, site of primary disease, American Society of Anesthesiologists score, and year of surgery (± 3 year). The parameters analyzed included age, gender, comorbid conditions, American Society of Anaesthesiologists class, diagnosis, procedure, and duration of operation, operative blood loss, and amount of homologous blood transfused. Conversion rate, intra and postoperative complications as were as reoperation rate, 30 d and long-term morbidity rate were also analyzed. For continuous variables, the Student's *t* test was used for normally distributed data the Mann-Whitney *U* test for non-normally distributed data. The Pearson's χ^2 tests, or the Fisher exact test as appropriate, were used for proportions.

RESULTS: Conversion to open surgery was necessary in 13 of 98 patients (13.3%). In the LPS group, operative time was 29 min longer and blood loss was 78 mL lower when compared to open colectomy (P = 0.03, P = 0.0001, respectively). Overall morbidity, anastomotic leak and readmission rate did not significantly differ between the two groups. A trend toward a reduction of wound complications was observed in the LPS when compared to open group (P = 0.09). In the LPS group, an earlier recovery of bowel function (P = 0.001) and a shorter length of stay (P = 0.03) were observed. After a median follow-up of 62 (range 12-132) mo 23 patients in the LPS group and 38 in the open group experienced long-term complications (LPS *vs* open, P = 0.03). Incisional hernia resulted to be the most frequent long-term complication with a significantly higher occurrence in the open group when compared to the laparoscopic one (P = 0.03).

CONCLUSION: Laparoscopic colectomy in obese patients is safe, does not jeopardize postoperative complications and resulted in lower incidence of long-term complications when compared with open cases.

Key words: Obesity; Colon cancer; Laparoscopy; Right colectomy; Left colectomy; Colorectal disease

Core tip: The best of our knowledge, this is the first case-matched control study reporting long-term complications in obese patients' undergone laparoscopic or open colectomy.

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INTRODUCTION

The role of laparoscopic surgery in obese patient with colorectal diseases is still object of debate, according to several papers published in the last decade, laparoscopy is feasible and safe[1-5]. However, controversial results have been reported in term of conversion rate, overall morbidity and reoperation rate, when obese patients are compared to their non-obese counterparts[1-8].

These controversial results could be partially explained based on the relative inexperience of the surgical team possibly due to an on-going learning curve, on the small sample size of the various studies, on the specific definition of obesity and on surgical heterogeneity[3-5,9]. In order to clarify this issue while avoiding some of the aforementioned biases, we have conducted a case-matched study comparing short and long-term outcomes of standardized right or left colectomy performed by laparoscopy or by open surgery in patients with a body mass index (BMI) > 30 kg/m^2. Data were extracted from a prospective collected database.

Main goal of the present study is to assess if the documented benefits of minimally invasive approach could be translated even in a high-risk patients such obese patients.

MATERIALS AND METHODS

Adult obese patients of both sexes candidate to a standardized right or left colectomy and who were consecutively admitted to our department from January 2002 to January 2012 were considered. Patients were identified from a prospective institutionally approved database currently recording demographics, biochemistry values, nutritional status, operative variables, and co-morbidity factors on admission, postoperative outcome and histopathologic findings of patients undergoing colon resection. The case group was selected from 118 obese patients who underwent laparoscopic colectomy identified from the Institutional Colon database. Patients were excluded if they underwent an emergency procedure (n = 13) or non-standardized colon operations (n = 7). Overall, the case group consisted of 98 patients. The control patients were selected from the same institutional database from January 2011, backward until we had identified one control subject for each case. Each case was manually matched with a control that had undergone open resection. The same exclusion criteria used for laparoscopic (LPS) patients were applied to the control patients' selection. The identification of control patients was done by a statistician (GR) who was unaware of postoperative outcomes. Control patients were selected to match for site of primary disease, American Society of Anesthesiologists (ASA) score, and year of surgery (± 3 year). Data collected from the hospital database, medical records and telephone calls were analyzed retrospectively.

Preoperative assessment included clinical examination, serologic evaluation, total colonoscopy and body CT scan. A virtual CT colonoscopy was additionally performed in case of incomplete colonoscopy examination. Co-morbidities on admission, as well as operative risk assessed by ASA score, were analyzed in both groups. The following details of the surgical procedure were recorded in all patients: duration of operation (min), operative blood loss (mL), and amount of homologous blood transfused (mL). Three surgeons (Staudacher C, Di Palo S, Vignali A) with extensive experience in open and laparoscopic colorectal surgery performed all the interventions[10,11]. For all the surgeons, the learning curve for laparoscopic colorectal surgery was completed before starting the present trial[12]. Patients underwent laparoscopic or open resection depending on surgeon's or patient's preference.

A mechanical anastomosis was intracorporeally fashioned in case of left colectomy, while in right colectomy, the specimen was divided extra corporeally (in laparoscopic operations) and an isoperistaltic side-to-side anastomosis was manually fashioned. Conversion to open surgery was defined when an abdominal incision longer than 7 cm was performed or when an abdominal incision was made earlier or differently from what planned at the beginning of the intervention.

All patients were treated according to the same intra and postoperative protocol: epidural analgesia maintenance for 3 d, nasogastric tube removal at the end of surgery, and bladder catheter removal on postoperative 2 d. Clear liquid diet was started on postoperative 1 d as tolerated by the patient. Postoperative infusion of fluids and electrolytes was given to all patients according to clinical requirements.

Tumor classification was done according to the 7th TNM edition[13]. Microbiological analysis and positive cultures proved all infectious complications. Patients were discharged after meeting the following conditions: bowel movement and full recovery of both ambulation ability and oral feeding. Registration of complications and need for an unexpected re-admission were recorded for the first 30 d following operation. The follow-up protocol consisted in outpatient clinic visits at 3 mo intervals for the first 2 years, then at 6 mo intervals for the next 3 years, then once a year. In patients with more than five years follow-up or with a benign disease, a systematic review of chart, office records as well as patient interview were done.

Statistical analysis

Descriptive data were reported as mean, median, standard deviation (SD), number of patients and percentage. For continuous variables, differences between groups were tested with the Student's t test for normally distributed data (based on Kolmogorov-Smirnov test) or the Mann-

Whitney *U* test for non-normally distributed data. The Pearson's χ^2 test, or the Fisher exact test as appropriate, was used for proportions. A two-sided significance level less than 0.05 were used to indicate statistical significance. Confidence intervals (95%CI) were reported when appropriate. The SPSS™ software package, version 18. For Windows (SPSS Inc, Chicago, IL) was used for all the statistical analyses.

RESULTS

Study population

Ninety-eight obese patients with colorectal diseases, identified from a prospectively maintained database, who underwent laparoscopic right or left colectomy over a 10 year period, were matched with 98 obese patients who underwent open resection.

The two groups were adequately matched for BMI, type of surgery, and operative risk as assessed by their ASA classification (Table 1). Moreover, a similar incidence of co-morbidities on admission was observed between the two groups (Table 2). The mean ± SD (range) BMI (kg/m^2) was 31.9 ± 1.6 (range 30-35.5) in the LPS group, and 32.3 ± 2.1 (range 30.1-36.4) in the open colectomy group. No significant differences were observed between the two groups with respect to demographics, indication for surgery (benign *vs* cancer), tumor stage (among cancer patients) as well as for the incidence of previous operations (Table 1).

Table 1 Demographics and clinical characteristics of the two groups *n* (%)

Variable	LPS (*n* = 98)	Open (*n* = 98)	*P* value
Age (yr)	66.9 ± 12.2	68.7 ± 15	0.31
Male/female	52/46	47/51	0.34
ASA score	2.3 ± 0.7	2.4 ± 0.9	0.57
BMI (kg/m^2)	31.9 ± 2.1	32.3 ± 2.5	0.13
Cancer/benign/disease	85/13	79/19	0.34
Previous surgery (%)[1]	8 (8.1)	10 (10.2)	0.30
Type of operation			
Right colectomy	57	57	
Left colectomy	41	41	
Tumour stage	*n* = 85	*n* = 79	0.77
Stage 0	13 (15.2)	9 (11.3)	
Stage 1	14 (16.5)	13 (16.3)	
Stage 2	29 (34.2)	32 (40.6)	
Stage 3	25 (29.4)	20 (25.4)	
Stage 4	4 (4.7)	5 (6.4)	

[1]Only abdominal surgeries were included; Values are reported as mean ± SD or *n* (%). BMI: Body mass index; LPS: Laparoscopic; ASA: American Society of Anesthesiologists.

Technical feasibility

Conversion to open surgery was necessary in 13 of 98 patients (13.3%). Reasons for conversion were as follows: obesity-hindering vision (*n* = 5), large tumour infiltrating adjacent organ/s (*n* = 2), bleeding from the ileocolic pedicle (*n* = 2), dense adhesions (*n* = 2), urgent splenectomy (*n* = 1) and ureteral damage (*n* = 1). Converted patients remained in the LPS group for an intention to treat analysis. In the converted patients, mean ± SD (range) time from beginning of the conversion procedure to open surgery was 22.5 ± 38.1 (15-80) min.

Table 2 reports the surgical characteristics of the two groups. The operation time was averagely 29 min (95%CI: 24.3-49.3) longer in LPS than open group (*P* = 0.03). Operative blood loss was 78 mL lower in the LPS group when compared to open surgery (*P* = 0.0001; 95%CI: 47.1-108.9). No significant differences were observed with respect to perioperative blood transfusion rate between the two groups. Moreover, among cancer patients a similar mean ± SD number of lymph nodes was retrieved in the operative specimen in the two groups (16.6 ± 10.1 in the open group *vs* 17.7 ± 11.5 in the LPS group, *P* = 0.57).

Postoperative outcomes

In the LPS group, a death occurred as a sequelae of an anastomotic leakage on postoperative day 5. No significant differences between the two groups were observed with respect to overall morbidity rate as well as for technical complications such as anastomotic leakage. Moreover, a similar incidence of hospital re-admission within 30 d and of reoperation rate was observed in the two groups (Table 2). Conversely, in the open group, the occurrence of wound complications was more than double when compared to the LPS group and the difference showed a trend toward a statistical significance (*P* = 0.09). In both groups, more than 30% of the postoperative infections occurred after discharge. A similar incidence of respiratory and cardiac complications was observed in the two groups (Table 3). When the converted cases were compared to the laparoscopically completed ones, a trend toward a longer duration of surgery (*P* = 0.07) and a longer length of stay was observed (*P* = 0.002). Converted patients experienced a higher complications rate when compared to patients who completed the operation laparoscopically; however the difference failed to reach statistical significance (22.8 *vs* 32.4, *P* = 0.62). Similar results in term of length of stay and overall complication rate were observed when converted and open surgery patients were compared (Table 4). Mean ± SD recovery of oral food intake occurred after 2.1 (1) d in the LPS and after 3.5 ± 1.5 d in the open surgery group (*P* = 0.001). Mean (median, SD) length of stay was 8.6 (8; 3.1) d in the LPS group and 10.4 (10; 4.9) d in the open surgery group (*P* = 0.03).

Long-term outcomes

At a median follow-up of 62 (range 12-132) mo, 23 patients in the LPS group and 38 in the open surgery group experienced long-term complications (LPS *vs* open, *P* = 0.03; Table 2). Incisional hernia was the most common complication in both groups and and its occurrence was more frequent in the open surgery group when compared to the laparoscopic one (*P* = 0.03). Among the converted patients, a 30.8% (4/13 pts) incisional hernia rate was observed.

Table 2 Comparison of co-morbidities, variables, complications (30 d morbidity) and Long-term complications between the two groups in study *n* (%)

		LPS (*n* = 98)	Open (*n* = 98)	*P* value
Co-morbidities	Diabetes	14	11	0.66
	Coronary artery disease[1]	13	15	0.84
	Hypertension	43	52	0.25
	Smoker	10	14	0.51
	Chronic obstructive pulmonary disease	5	3	0.72
	Steroid use	2	3	0.91
Variable	Operative time (min)	193 (71)	164 (111)	0.03
	Blood loss (mL)	177 (76)	255 (102)	0.0001
	No of transfused patients	11 (11.2)	16 (16.3)	0.33
	Conversion rate	13 (13.3)	NA	
Complications (30 d morbidity)	Overall	27 (27.6)	33 (33.7)	0.4
	Infectious[2]	13 (13.7)	21 (21.7)	0.13
	Noninfectious[2]	9 (9.2)	10 (10.2)	0.8
	Anastomotic leak[2]	7 (7.1)	5 (5.1)	0.78
	Readmission	7 (7.1)	11 (11.2)	0.56
	Reoperation	8 (8.1)	9 (9.2)	0.8
	Length of stay	8 (3.1)	10.4 (4.9)	0.03
	Mortality	1 (1.02)	0 (0.0)	0.9
Long-term complications	Incisional hernia	17	31	0.03
	Intestinal obstruction	5	6	0.48
	Anastomotic stricture	4	4	0.86
	Overall	23	38	0.03

[1]Including: History of angina, percutaneous cardiac intervention, cardiac operation, or myocardial infarction within 6 mo of operation; [2]Number of single type of complication do not add up to the number of overall complication within the two groups because of the possible occurrence of more than one type of complication in some patients; all values within parenthesis indicate percentage values. LPS: Laparoscopic.

Table 3 Postoperative complications in details *n* (%)

	LPS (*n* = 98)	Open (*n* = 98)
Infectious complications		
Wound complications[1]		
Wound infections	8 (8.2)	15 (15.4)
Wound disruption	-	2 (2.04)
Abdominal abscess	1 (1.06)	2 (2.04)
Pneumonia	2 (2.04)	3 (3.1)
Urinary tract	2 (2.04)	1 (1.06)
Non-infectious complications		
Cardiologic	2 (2.04)	3 (3.1)
Ileus	3 (3.1)	3 (3.1)
Intestinal obstruction	3 (3.1)	4 (4.1)
Bleeding	1 (1.01)	-

[1]Laparoscopic (LPS) *vs* open, $P = 0.09$.

DISCUSSION

The global prevalence of obesity means that surgeons are increasingly faced with these high-risk patients. The choice of optimal operative approach and technique becomes extremely actual and crucial. The vast majority of the studies available in the literature addressing the issue of mini-invasive approach and obesity compares obese patients to their non-obese counterparts[2-6]. In our opinion, in order to better evaluate the effective impact of mini-invasive approach in obese patients, it is important to compare open and laparoscopic colectomy outcomes in the specific population of obese patients only. A definitive answer whether laparoscopic surgery would be preferable in the obese to the open approach can only be obtained by a randomized controlled trial. To the best of our knowledge, there are no RCTs in the literature specifically addressing this issue. To limit the biases related to the design of the study and in an attempt to minimize surgical heterogeneicity[14], a single center case-matched study was performed including only well standardized surgical procedures.

In previous studies, obesity has been identified as one of the factors associated with a higher conversion rate[15-19]. In the present trial, a conversion rate of 13.3% has been obtained, which is within the range (0%-39%) previously reported by other studies dealing with this issue[1-6]. This rate is however higher when compared to the 2.6% conversion rate after laparoscopic right colectomy or the 5.2% conversion rate in left LPS colectomies reported in studies performed by our Institution in the non-obese population[20,21]. These findings are in accordance with results from Tekkis and co-workers who identified obesity as an independent predictor of conversion to open surgery at multivariate analysis with an odd-ratio of 2.2 for patients with a BMI > 28.5 kg/m^2 derived from a large series 1253 subjects[22]. Moreover an increasing BMI was associated with a proportionally higher conversion rates in data extracted from the laparoscopic colorectal surgery study group (LCSSG)" on 5853 recruited patients[23].

A possible argument against the adoption of the mini-invasive approach in obese patients is that converted patients resulted in poor short and long-term outcomes when compared to patients who successfully completed the operation laparoscopically[24,25]. In our experience,

Table 4 Outcomes of laparoscopically completed, converted and open cases

Variable	LPS completed (n = 85)	Converted (n = 13)	Open (n = 98)	P value
Operative time (min)	175 (61)	210 (86)	164 (111)	0.07[1] 0.08[2]
Morbidity rate	22.8%	32.4%	33.7%	0.55[1] 0.91[2]
Length of stay (d)	7.2 (2.5)	9.6 (3.2)	10.4 (4.9)	0.002[1] 0.52[2]

[1]Laparoscopic (LPS) completed *vs* converted; [2]Converted *vs* open. Values are expressed as mean (SD) or percentages.

in the converted patients, no significant difference was observed in term of postoperative morbidity when compared to laparoscopically completed cases. Similar results were reported by other authors[26,27]. Possible explanation may include the wide experience of the surgical team, in the appropriate patients' selection, or to the rapid decision to convert thus minimizing potentially adverse outcomes[1,4,10,22].

In the present series, the overall morbidity rates did not differ between the two groups. Similarly, despite the incidence of infectious complications was about twice higher in patients in the open surgery group when compared to laparoscopic (23.6% *vs* 11%), the difference failed to reach statistical significance.

Only with respect to wound complications, a trend toward a lower rate was observed in the LPS group. These latter findings are consistent with the data recently reported by Wick *et al*[28] and Mustain *et al*[29], who identified open surgery as an independent risk factors for surgical site infections in a large series of obese patients undergoing laparoscopic and open colorectal surgery[28,29].

In the present series, the incidence of anastomotic leakage was similar in the two groups. Delaney and coworkers reported similar results in the only other, to the best of our knowledge, case-matched study comparing laparoscopic to open colectomy in obese patients,. These authors reported an absence of statistical difference, both for the overall complications as well as for anastomotic leakage rate[27]. The absence of an adverse impact of laparoscopic colectomy on anastomotic leakage rate in the obese patients undergone laparoscopic colectomy has been recently supported by a review paper by Martin and Stocchi[9] reporting data from high volume institutions.

Moreover, patients in the LPS group experienced a shorter recovery of bowel function and a shorter length of stay when compared to their open surgery counterparts. These findings are consistent with the results reported by a large meta-analyses analyzing the outcomes of 2512 procedures from 12 RCT trials comparing LPS and the open approach for colorectal diseases in the non-obese population[30]. In our series, the earlier recovery of bowel function, the shorter length of stay as well as the lower intraoperative blood loss and a trend toward a reduction of wound complications observed in the LPS group, deserve major consideration, as these findings indicate that some of the wide-reported short-term benefits of the mini-invasive approach are maintained even in high-risk patients, also suggesting that paradoxically, these are the patients who stands to benefit the most laparoscopic surgery.

With respect to long-term complications, patients in the LPS group experienced a significantly lower incidence of overall complications when compared to their open surgery counterparts. In particular a higher incisional hernia rate was observed in the open surgery group. Few data are available in the literature on this subject reporting controversial results. No difference in term of incisional hernias between laparoscopic or open approach has been reported or, conversely the mini-invasive approach was preferred when obese *vs* non obese patients are compared[31,32]. To the best of our knowledge, no study has reported data on long-term complications in obese patients treated with mini-invasive or with conventional approach. The mechanisms for incisional hernia occurrence have not been yet clarified. Potential risk factors have been identified and categorized into patient-related (advanced age, obesity, nutritional status,) disease and surgery-related such as emergency operation, postoperative wound infections, reoperations and others[33-35]. Moreover, an association was recently reported by Rullier *et al*[36] between the rate of hernia and the length of incision. These authors found an incisional hernia rate of 33.0% at median follow-up period of 51 mo in open group compared to 13.5% in the LPS group of patients who underwent rectal resection.

In conclusions, although there are some limitations to the study resulting from the non-randomized design, to the possible bias in patient selection for laparoscopic surgery, and to the fact that patients were treated in a single institution, our findings indicate that laparoscopic surgery can be safely performed in obese patients with colorectal disease. Moreover, minimally invasive approach has no adverse impact on postoperative complications, resulting in reduced length of stay and lower incidence of long-term incisional hernia when compared to conventional colectomy.

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COMMENTS

Background

The safety and the benefits of laparoscopic colon resection, including less post-operative pain, faster recovery of bowel function, earlier mobilization, less morbidity, reduction of hospital stay, and smaller scars, have been underlined by several studies, making it now the preferred approach in the surgical management of many colorectal diseases. Obese patients are considered to be at high perioperative risks. Therefore laparoscopic surgery may be particularly advantageous in obese patients. On the other hand a colorectal resection is more difficult in obese subjects due to obesity hindering visualization and dissection of tissue planes that lead to longer operative time and increase blood transfu-

sion requirement, thus possibly impair the benefits of laparoscopic colectomy.

Research frontiers

The study performed a single center study in which patients were matched for body mass index, site of primary disease, American Society of Anesthesiologists score, and year of surgery. Moreover only well standardized surgical procedures (left and right colectomy) were included. However, in order to better evaluate the real impact of minimally-invasive approach in obese patients, a randomized controlled trial should be conducted.

Innovations and breakthroughs

The vast majority of previous studies, focusing on laparoscopic colectomies in obese patients, compared obese to non-obese subjects. No randomized study has been conducted. Only one case matched study compared open and laparoscopic approach in obese patients. This is the first study that analyses long-term outcomes. The principals finding of this study is that the documented benefits of laparoscopic colon resection could be translated even in a high-risk group, such obese patients, since this approach did not impair postoperative outcomes and resulted in lower incidence of long-term complications when matched with open surgery cases.

Applications

Providing that experienced surgeons are involved, laparoscopic colorectal resection should be offered to obese patients considering its benefits when compared to conventional open surgery.

Peer review

The authors analyze the feasibility of laparoscopic colectomy in obese patients. There are not randomized trials comparing the outcome of colectomy in obese and non-obese patients. The results confirm previous studies on the efficacy and safety of laparoscopic left and right colectomy in obese subjects. The literature on this topic is scarce, and, although another case-match study was previously published, this is the only one that analyses long term results.

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