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Impact of obesity on short-term results of laparoscopic rectal cancer resection

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Abstract
Introduction The influence of obesity [body mass index (BMI) $\geq$ 30 kg/m^2] on the outcome of laparoscopic colorectal surgery remains controversial. The complexity of rectal laparoscopic resections requires a specific assessment of the impact of obesity on the feasibility and short-term results of the surgery.
Methods Between February 2002 and May 2007, 210 laparoscopic mesorectal excisions were performed. Demographic, oncologic and perioperative data were entered in a prospective database. Twenty-four patients (11.4%) with BMI over 30 kg/m^2 formed the obese group (OG). The outcomes in the OG and the nonobese group (NOG) were compared.
Results There were significantly more American Society of Anesthesiologists (ASA) score 3 patients (26% in OG versus 9% in NOG; $p = 0.03$) in the obese group. Obese patients experienced longer operative times (513 min in OG vs. 421 min in NOG; $p < 0.01$) and more frequent conversion to laparotomy (46% in OG vs. 12% in NOG; $p < 0.001$). Morbidity grade 1 was higher in the obese group (29.2% vs. 9.7% in NOG; $p = 0.01$), but there was no difference in regards to morbidity grade 2 or more (33.3% in OG vs. 32.3% in NOG). In addition, conversion to laparotomy among the obese did not increase significantly morbidity grade 2 or higher (5 of 11 for OG converted vs. 3 of 13 for OG nonconverted; $p = 0.39$). Regarding the oncological parameters (e.g. number of lymph nodes removed, distal and lateral margins) there was no difference between groups.
Conclusion Obesity increases operative duration and conversion rate of rectal laparoscopic resection for cancer. Although obesity is associated with a worse preoperative evaluation, there is no increase in relevant morbidity and no impairment of oncological safety.

Keywords Colorectal, cancer · Obesity · Laparoscopy · Morbidity

Today, obesity is a major public health problem: 10.7% of adults in France and more than 20% in the USA have body mass index (BMI) $\geq$ 30 kg/m^2 [1, 2]. The increasing prevalence of obesity is particularly relevant in digestive oncology, because of the well-known association between obesity and the occurrence of colorectal cancer [relative risk (RR) = 1.84] [3].

The overall risks of surgery are generally thought to be higher in obese individuals. Obesity leads to a number of disorders, including diabetes, hypertension, cardiovascular diseases, and dyslipidemia, that can affect the care of surgical patients. Obesity has been associated with longer operating time [4] and more parietal complications [5] in several surgical specialties (e.g., gynecologic, orthopedic, cardiovascular).

In open colorectal surgery, obesity appears to have few adverse effects on the results of colectomy, but does increase the overall morbidity rate for rectal resections [6]. With the development of laparoscopy, obesity becomes both a negative and a positive challenge: the surgical

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procedure is made more difficult because of obesity, but the obese are perhaps those who benefit most from a minimally invasive surgery. The impact of obesity has been measured mainly for colon resections, with divergent results [7]. The specific characteristics of laparoscopic rectal resections among the obese have been rarely studied. The purpose of our study was to evaluate the feasibility of laparoscopic rectal resections for cancer in the obese and to measure the impact on short-term results.

Patients and methods

Between February 2002 and May 2007, 297 rectal resections for primitive adenocarcinoma were carried out at our institution. A laparoscopic approach was performed in 210 cases. Exclusion criteria for laparoscopy were T4 rectal tumor, synchronous liver resection, or patient choice.

A prospective database comprising 35 demographic, oncological, and surgical items was used for the statistical analysis. Data related to morbidity were collected and stratified as recommended by Dindo et al. [9].

Care protocols remained stable throughout the study period. Preoperative assessment included endorectal ultrasonography, pelvic magnetic resonance, and thoraco-abdominopelvic computed tomography. Preoperative irradiation or chemoradiation was indicated for mid- and low-rectal T3T4 tumours. The precise course of the procedure has been described previously [8]. Conversion to laparotomy was defined by the impossibility of implementing the entire procedure laparoscopically, regardless of the size or location of the incision. Some points of care were subject to special attention, especially among obese patients. In order to prevent compression risks, we carefully positioned the patients on the operating table, including positioning their feet and legs in rigid boots, setting their arms along the trunk with protective circular foam rubber cushions, and strapping them to the table at chest level. The protocol for anesthesia was the same for all patients and well adapted to the obese: the use of rapidly eliminated drugs (propofol and remifentanil), curare monitoring, and the maintenance of anesthesia with halogenated ether (desflurane). Mechanical ventilation employed positive end-expiratory pressure (PEEP) and alveolar recruitment exercises in obese patients to prevent the risk of postoperative atelectasis. Pneumoperitoneum pressure was reduced to the very least that was compatible with satisfactory exposition, and was restricted to a maximum of 12 mmHg. Postoperative mobilization and physiotherapy were conducted according to our fast-track protocol. Prevention of the risk of deep venous thrombosis involved elastic lower-limb compression and heparin treatment.

Comparisons between groups were performed with standard statistical tests (e.g., chi-square test, Fisher's exact test, Mann–Whitney *U*-test). Differences were taken to be statistically significant at $p < 0.05$. A logistic regression model was prepared to explain the conversion based on a single factor: BMI.

Results

Mean BMI of the entire patient series was 24.7 kg/m^2. Eighty-eight patients (41.9%) were overweight (BMI 25–30 kg/m^2), and 24 patients (11.4%) were obese (BMI $\geq$ 30 kg/m^2). These 24 patients formed the obese group (OG), which was compared with the rest of the population, the nonobese group (NOG).

There were no differences in epidemiological data between the two groups (Table 1). However, there were significantly more ASA score 3 patients in the obese group (OG) versus the nonobese group (NOG) (25% vs. 9%, respectively; $p = 0.016$).

The laparotomy conversion rate increased significantly, from 12% in the NOG to 48% in the OG ($p = 0.001$). The probability of conversion increased continuously with increasing BMI as shown in Fig. 1. Conversion in the obese was a "small" conversion to a Pfannenstiel incision at the

Table 1 Demographic and clinical characteristics of the study population

	BMI < 30 kg/m^2 ($n = 186$)	BMI $\geq$ 30 kg/m^2 ($n = 24$)	*p*
Sex ratio	1.7	1.2	0.58
Age			
Mean (CI)	62 (10.7)	62.5 (7.6)	0.93
ASA			
1	45 (24.6%)	3 (13%)	0.029
2	122 (66.7%)	14 (60.9%)	
3	16 (8.7%)	6 (26.1%)	
Tumor location			
Upper	28 (15.1%)	0 (0%)	0.12
Mid	80 (43%)	13 (54.2%)	
Low	78 (41.9%)	11 (45.8%)	
Preoperative radiotherapy	139 (74.7%)	20 (83.3%)	0.6
Operation			
Partial proctectomy	20 (10.8%)	0 (0%)	0.25
Total proctectomy	95 (51.1%)	11 (45.8%)	
Anoproctectomy	58 (31.2%)	11 (45.8%)	
Amputation	13 (7%)	2 (8%)	

ASA American Society of Anesthesiologists, *CI* confidence interval

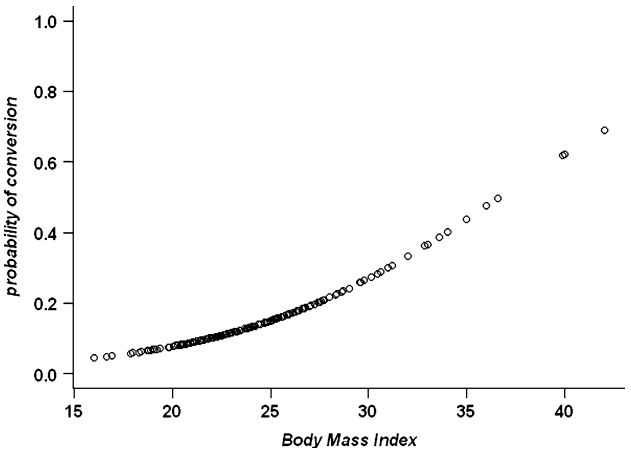

Fig. 1 Representation of the probability of conversion in relation to BMI

end of the pelvic dissection in six cases and a "large" conversion to median laparotomy in five cases for immediate difficulties of exposition. There was no conversion for hemodynamic or respiratory intolerance of the laparoscopy.

Obese patients had significantly longer procedure durations. The average increase in duration was 96 min. (Table 2). Although a trend towards greater morbidity among obese was noted (Table 2), this trend was not significant (62.5% in OG vs. 41.9% in NOG; $p = 0.09$). For morbidity grade 2 or higher (relevant morbidity), both groups had the same rate (33.3% in OG vs. 32.3% in NOG; $p = 0.99$). The only significant difference was observed with grade 1 morbidity (37.5% in OG vs. 10.7% in NOG; $p = 0.007$). Grade 1 complications in the obese were: three wound infections, two ileus, and two atelectasis.

Table 2 Postoperative outcomes

	BMI < 30 kg/m^2 ($n = 186$)	BMI ≥ 30 kg/m^2 ($n = 24$)	p
Conversion	23 (12.4%)	11 (45.8%)	<0.001
Operative time (min)			
Mean (CI)	421 (97)	513 (127)	<0.001
Mortality	1 (0.5%)	1 (4%)	0.2
Overall morbidity	78 (41.9%)	15 (62.5%)	0.09
Grade 1	18 (9.7%)	7 (29.2%)	0.012
Grade 2 and more	60 (32.3%)	8 (33.3%)	0.99
Reoperation	16 (8.6%)	2 (8.3%)	0.73
Fistula	25 (13.4%)	3 (12.5%)	0.84
Respiratory complication	6 (3.2%)	4 (16.6%)	0.02
Wound infection	7 (3.8%)	3 (12.5%)	0.09
Duration of hospitalization			
Mean (CI)	12.8 (11.2)	15.6 (12.5)	0.22

Table 3 Short-term oncologic results

	BMI < 30 kg/m^2 ($n = 186$)	BMI ≥ 30 kg/m^2 ($n = 24$)	p
Stage			
0	18 (9.7%)	1 (4.2%)	0.17
1	70 (37.6%)	4 (16.7%)	
2	33 (17.7%)	6 (25%)	
3	51 (27.4%)	11 (45.8%)	
4	14 (7.5%)	2 (8.3%)	
Nodal sampling			
Mean (CI)	12.7 (6.1)	14.3 (7.5)	0.23
Distal margin			
Mean (CI)	26.4 (2)	21.8 (1.5)	0.16
Lateral margin			
Mean (CI)	8.4 (6.9)	7.9 (6.3)	0.757
R1 resection	22 (11.9%)	1 (4.2%)	0.42

By focusing on the type of complication, it appeared that the obese did not experience more fistulas or compressions. The only significant difference between the groups concerned respiratory complications (primarily grade 1 atelectasis). Similarly, there was no difference in duration of hospitalization between the groups (15.6 days in OG vs. 12.8 days in NOG; $p = 0.22$).

Conversion to an open procedure is not associated with a worse outcome in obese patients. Regarding morbidity of grade 2 or higher, 5 of 11 converted obese patients versus 3 of 13 nonconverted obese patients experienced morbidity ($p = 0.39$).

Regarding the short-term oncologic outcomes, there were no differences between the two groups (Table 3).

Discussion

This is the first study comparing the results of laparoscopic rectal resections for cancer in obese and nonobese patients using the Western definition of obesity (BMI ≥ 30 kg/m^2). This study shows that laparoscopic rectal resections for cancer are more difficult in obese patients, with an increase in the conversion to laparotomy and operating hours, and without thereby significantly increased overall relevant morbidity.

The influence of obesity on the results of resection for rectal cancer has been evaluated in open surgery. Benoist et al. [6] described an increase in mortality rates (5% among obese vs. 0.5% among nonobese patients; $p < 0.02$), fistula rates (16% among obese vs. 6% among nonobese patients; $p < 0.05$), and transfusion rates (43% among obese vs. 19% among nonobese patients). Furthermore, the duration of surgery was longer for obese patients in this study, as well as that of Blee et al. [10].

The available data on the impact of obesity in colorectal surgery has focused on colonic resections. In open colonic surgery, Benoist et al. did not provide specific evidence of the influence of obesity on their short-term results. In laparoscopic colonic surgery, data on the impact of obesity are discordant in the literature. For some, there is a significant increase in conversion rates [11] and complications rates [12] associated with obesity. For others, there is no difference between obese and nonobese patients with regard to short-term results [13]. Recently, in the largest published study (5,853 laparoscopic colonic resections), operative time was longer and conversion rate and occurrence of intra-abdominal complications were higher for obese patients [14].

Delaney et al. [15] have studied the results of colectomy (open and laparoscopic) associated with obesity. They found no difference in operative time, complication rate or cost for obese patients. They also found that length of the hospital stay was shorter after laparoscopy.

The results of resection of the colon cannot reasonably be extrapolated for the evaluation of rectal resection. Laparoscopic rectal cancer resections are still not widely available, probably because they are time consuming and technically difficult. The specific difficulties encountered with resections mainly concern exposure during the pelvic dissection, nervous conservation, and rectal transection.

The literature assessing laparoscopic rectal resections remains poor, mainly being supported by monocentric evaluations from specialized teams [16]. There is only one level 1 randomized study with short- and long-term assessments [17, 18]. The feasibility of these procedures is still under discussion. The conversion rate for most specialized teams is around 15%, but increases up to 34% in the multicentric Conventional versus Laparoscopic-Assisted Surgery in patients with Colorectal Cancer (CLASICC) trial [17]. More recently, a decreased risk of incisional hernia (from 33% in open surgery to 13% in laparoscopy at 5 years) after laparoscopic rectal resection has also been clearly shown [19]. This last point could be of particular importance in obese patients.

One might have expected in our study to see an increase in the rate of complications in the obese group, especially since they had worse ASA assessment. Surprisingly, there was no difference between the two groups regarding morbidity grade 2 or more. The significant increase in morbidity grade 1 (defined by Dindo as any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions) in our study had no clinical significance. This result may in itself be explained by the laparoscopic approach. Our results, however, showed difficulties in the feasibility of the procedure, longer operating times, and increases in the conversion rate, all associated with obesity. These difficulties are mainly explained by the problems of exposure (layering of intestinal loops, volume of mesorectum) and dissection difficulties due to the thickness of fat tissue, particularly in cases of visceral obesity. Other authors have also found obesity to be a risk factor for conversion [20, 21, 22]. In a study assessing risk factors for conversion derived from the multicenter CLASICC trial, Thorpe et al. [20] found that male gender, BMI, and location of the rectal cancer were independent risk factors for conversion. In addition to a simple failure of the procedure, the occurrence of a conversion in this study involved an increase in complications as compared with patients who were not converted or subjected to open surgery ($p < 0.002$). In our study, conversion was not associated with increased relevant morbidity.

Recently, three studies have evaluated difficulties in rectal laparoscopic resections. Veenhof et al. [23] reported that laparoscopic surgery in male, irradiated, and obese patients with lower tumors seemed more difficult. In this study of 50 resections, blood loss was higher among the obese. Agha et al. [21], assessing the risk of conversion in 300 rectal resections, found male gender, higher BMI, and the presence of T4 tumors to be risk factors for conversion. Early postoperative complications were more frequent in the converted group than in the laparoscopic group. The third study, conducted by Laurent et al. [24], covering 200 laparoscopic TME, found that men with a mechanical anastomosis had a probability of conversion and morbidity that was increased by a factor of three. However, the influence of BMI was not taken into account in this study.

One Japanese study has specifically evaluated the impact of obesity in laparoscopic rectal surgery [22]. There were only 46 patients included in the study and the definition of obesity (BMI $\geq$ 25 kg/m^2) does not correspond to Western criteria. With such a threshold, neither the duration of surgery nor the morbidity rate differed. However, taking a computed tomography (CT) scan assessment of visceral obesity as a definition of obesity, there was a significant increase in the duration of surgery and morbidity rate in visceral obese patients. Such an assessment might be useful for distinguishing obese patients at a high risk for conversion.

Our results lead us to conclude that obesity alters the feasibility (conversion rate and operative time) but not the safety (postoperative relevant morbidity) or oncological security (margins and local control) of laparoscopic rectal resection for cancer. These difficulties may restrict laparoscopy to experienced surgeons and favorable types of obesity. Moreover, we advocate the completion of controlled trials, which would more clearly illuminate the possible advantage of the laparoscopic approach to mesorectal excision for cancer in obese patients.

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