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ORIGINAL ARTICLE

Minimally invasive ileal pouch-anal anastomosis for patients with obesity: a propensity score-matched analysis

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Abstract

Background Obesity is a risk factor for failure of pouch surgery completion. However, little is known about the impact of obesity on short-term outcomes after minimally invasive (MIS) ileal pouch-anal anastomosis (IPAA). This study aimed to assess short-term postoperative outcomes in patients undergoing MIS total proctocolectomy (TPC) with IPAA in patients with and without obesity.

Materials and methods All adult patients (≥ 18 years old) who underwent MIS IPAA as reported in the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) Participant User Files 2007 to 2018 were included. Patients were divided according to their body mass index (BMI) into two groups (BMI ≥ 30 kg/m^2 vs. BMI < 30 kg/m^2). Baseline demographics, preoperative risk factors including comorbidities, American Society of Anesthesiologists Class, smoking, different preoperative laboratory parameters, and operation time were compared between the two groups. Propensity score matching (1:1) based on logistic regression with a caliber distance of 0.2 of the standard deviation of the logit of the propensity score was used to overcome biases due to different distributions of the covariates. Thirty-day postoperative complications including overall surgical and medical complications, surgical site infection (SSI), organ space infection, systemic sepsis, 30-day mortality, and length of stay were compared between both groups.

Results Initially, a total of 2158 patients (402 (18.6%) obese and 1756 (81.4%) nonobese patients) were identified. After 1:1 matching, 402 patients remained in each group. Patients with obesity had a higher risk of postoperative organ/space infection (12.9%; vs. 6.5%; p-value 0.002) compared to nonobese patients. There was no difference between the groups regarding the risk of postoperative sepsis, septic shock, need for blood transfusion, wound disruption, superficial SSI, deep SSI, respiratory, renal, major adverse cardiovascular events (myocardial infarction, stroke, cardiac arrest requiring cardiopulmonary resuscitation), venous thromboembolism, 30-day mortality, and length of stay.

Conclusion MIS IPAA can be safely performed in patients with obesity. However, patients with obesity have a 2-fold risk of organ space infection compared to patients without obesity. Loss of weight before MIS IPAA is recommended not only to allow for pouch creation but also to decrease organ space infections.

Keywords Minimally invasive surgery · Ileal pouch-anal anastomosis · Surgical site infection · Ulcerative colitis

Introduction

Restorative proctocolectomy with ileal pouch-anal anastomosis (IPAA) is the surgical treatment of choice for patients with ulcerative colitis (UC) who failed medical management as it improves both quality of life and functional outcomes [1, 2]. However, inadequate mesenteric length and lack of working space in the confined anatomical planes of the narrow pelvis represent technical challenges, which are directly related to increasing body mass index (BMI) [3]. Furthermore, the increasing adoption of minimally invasive surgery (MIS)

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platforms may bear challenges in this population given the loss of tactile sense related to the heavy mesentery and the fragile tissue prone to bleeding in patients with obesity [3, 4]. This might translate into worse postoperative outcomes secondary to bleeding or anastomotic leak. In this present study, we attempted to assess whether the touted benefits of MIS apply to the challenging population of obese patients undergoing IPAA surgery.

Methods

All adult patients undergoing MIS total proctocolectomy (TPC) with IPAA (Current Procedure Terminology code: 44211) for ulcerative colitis (International Classification of Diseases (ICD) codes: ICD-9-CM: 556.x and ICD-10-CM: K51.x) from 2007 to 2018 and reported in the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database were included.

The ACS-NSQIP is a validated national database for which trained data abstractors extract patients' information based on predefined data extraction sheets according to standardized definitions. Patients are identified for inclusion in the final dataset based on a random sample with approximately 20% of all cases retained [5].

Patients were divided according to their body mass index (BMI) into two groups: patients with obesity (BMI ≥ 30 kg/m^2) vs. patients without obesity (BMI < 30 kg/m^2). Baseline demographics, comorbidities including diabetes mellitus, hypertension, congestive heart failure, chronic obstructive pulmonary disease, bleeding disorders, anemia, hypoalbuminemia, dyspnea, smoking, American Society of Anesthesiologists (ASA) class, chronic steroid use, recent weight loss, functional health status, and operation time were compared between both groups. Further assessed were 30-day complications according to the standardized ACS-NSQIP definitions, 30-day mortality, and length of stay.

Surgical complications included any surgical site infection (*superficial* defined as an infection that involves only skin or subcutaneous tissue of the surgical incision, *deep* defined as an infection that involves any tissue beneath skin and immediate subcutaneous fat, or *organ space infection* defined as an infection that involves any part of the anatomy (e.g., organ or space), other than the incision which was opened and manipulated during surgery). It also can be assigned in the case of anastomotic leakage, wound disruption, systemic sepsis (septic shock or sepsis), and/or need for blood transfusion. Medical complications included any respiratory complication (pneumonia, need for ventilation more than 2 days, unplanned intubation), any renal complication (acute renal failure or chronic renal insufficiency), vascular thromboembolism (deep venous thrombosis or pulmonary embolism), major adverse cardiovascular events (myocardial infarction, stroke, or cardiac arrest requiring cardiopulmonary resuscitation), and/or urinary tract infection.

Statistical analysis

Categorical variables were summarized as frequencies and percentages and continuous variable as median (interquartile range). A propensity score matching analysis (1:1) based on logistic regression with a caliber distance of 0.2 of the standard deviation of the logit of the propensity score using nearest neighborhood matching was used to overcome biases due to different distributions of the covariates. Covariates used in the model included age, sex, preoperative comorbidities such as diabetes mellitus, dyspnea, hypertension, congestive heart failure, chronic steroid use, more than 10% loss of weight during the last 6 months, preoperative hypoalbuminemia, and ASA class. The differences between both groups were assessed using chi-squared test or Fisher's exact test as appropriate for categorical variables and Mann-Whitney test for continuous variables. All tests were two-sided and an alpha level < 0.05 was considered statistically significant. Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS, Version 25; SPSS, Inc., Armonk, NY, USA).

Results

Initially, a total of 2158 patients, 402 (18.6%) with obesity and 1756 (81.4%) without obesity, were identified. After 1:1 matching, 402 patients remained in each group.

Before matching, the overall median BMI was 25.1 kg/m^2 (IQR 22.2–29). Patients with obesity were older and had higher rates of diabetes mellitus, dyspnea, and hypertension. Furthermore, surgical duration was significantly longer in the obese group (Table 1). After propensity score matching, baseline demographics, surgical risk factors, and operation time were balanced between the groups (Table 2). Chronic steroid use, anemia, and hypoalbuminemia were the most prevalent preoperative risk factors in both groups.

Patients with obesity had a higher rate of postoperative organ space infection (12.9%; vs. 6.5%; p-value 0.002) compared to patients without obesity. There was no difference between the two groups regarding overall surgical complications, postoperative sepsis, septic shock, need for blood transfusion, wound disruption, superficial surgical site infection (SSI), deep SSI, overall medical complications, respiratory, renal, major adverse cardiovascular events, venous thromboembolism, 30-day mortality, and length of stay (Table 3).

Table 1 Baseline demographics, preoperative risk factors, and operation time before matching

	BMI < 30 n = 1756	BMI ≥ 30 n = 402	P-value
BMI, median (IQR)	**24 (21.5–26.6)**	**33 (31–36)**	**< 0.0001**
Age; median (IQR)	**37 (28–50)**	**43 (34–54)**	**< 0.0001**
Male	999 (56.9%)	217 (54.0%)	0.289
DM	**48 (2.7%)**	**35 (8.7%)**	**< 0.0001**
Current smoker	110 (6.3%)	24 (6.0%)	0.825
Dyspnea	**29 (1.7%)**	**15 (3.7%)**	**0.014**
Functional dependence	8 (0.5%)	4 (1.0%)	0.224
COPD	10 (0.6%)	4 (1.0%)	0.365
CHF	1 (0.1%)	0	> 0.99
HTN	**157 (8.9%)**	**105 (26.1%)**	**< 0.0001**
Chronic steroid use	**906 (51.6%)**	**184 (45.8%)**	**0.035**
> 10% loss of weight/last 6 months	**117 (6.7%)**	**9 (2.2%)**	**< 0.0001**
Bleeding disorder	35 (2.0%)	11 (2.7%)	0.341
Preoperative blood transfusion	12 (0.7%)	3 (0.7%)	0.892
ASA ≥ 3	**420 (23.9%)**	**150 (37.3%)**	**< 0.0001**
Operation time	**287 (225–355)**	**332 (255–416)**	**< 0.0001**
Hypoalbuminemia			**0.023**
Yes	**320 (18.2%)**	**51 (12.7%)**	
Missing	**651 (37.1%)**	**157 (39.1%)**	
Anemia			0.723
Yes	405 (23.1%)	90 (22.4%)	
Missing	124 (7.1%)	33 (8.2%)	
Thrombocytopenia			0.531
Yes	27 (1.5%)	7 (1.7%)	
Missing	145 (8.3%)	40 (10.0%)	

Bold indicates statiscially signficant

BMI body mass index, *DM* diabetes mellitus, *HCT* hematocrit, *COPD* chronic obstructive pulmonary disease, *CHF* congestive heart failure, *HTN* hypertension requiring medications, *ASA* American Society of Anesthesiologists

Discussion

This nationwide analysis provides an insight about the impact of obesity on short-term complications after MIS TPC with IPAA for ulcerative colitis. Overall surgical and medical complications, 30-day mortality, and length of stay were comparable between patients with obesity and the matched comparative cohort of patients without obesity. However, patients with obesity had a 2-fold increased risk of organ space infection after matching for the baseline confounders. Preoperative weight loss should be encouraged to minimize organ space infections.

Up to 30% of patients with ulcerative colitis will require colectomy during their lifetime. And, about 31.5% of patients suffering from ulcerative colitis have concomitant obesity [6]. Therefore, a deep understanding of interaction of obesity with different aspects of the disease processes and its effect on treatment strategies is pivotal. Pathophysiological mechanisms related to obesity increase the prevalence of several comorbidities, which in turn either directly or indirectly impact surgical outcomes [6]. Furthermore, surgery in patients with obesity is challenging from a technical standpoint given the highly vascularized and heavy yet fragile mesentery. In patients with chronic ulcerative colitis, surgical management is further complicated by the chronic debilitating nature of the disease and the effect of chronic medical management on patients' condition and healing processes [6]. Interestingly, in our cohort, about 19% of patients who underwent MIS IPAA had a body mass index ≥ 30 kg/m^2, which is slightly higher than what has been reported before when both open and MIS IPAA were included [7, 8]. This might reflect the general trend to more widespread adoption of MIS in patients with obesity [4, 9, 10]. This is important in light of conflicting results in the literature about the impact of obesity on short-term outcomes after surgery for inflammatory bowel diseases [7, 8, 11–14].

Before matching, patients with obesity had a longer operation time, which might indirectly reflect the technical

Table 2 Baseline demographics, preoperative risk factors, and operation time after matching

	BMI < 30 n = 402	BMI ≥ 30 n = 402	P-value
Age; median (IQR)	44 (32–56)	43 (34–54)	0.997
Male	237 (59.0%)	217 (54.0%)	0.155
DM	28 (7.0%)	35 (8.7%)	0.358
Current smoker	34 (8.5%)	24 (6.0%)	0.172
Dyspnea	13 (3.2%)	15 (3.7%)	0.848
Functional dependence	5 (1.2%)	4 (1.0%)	> 0.99
COPD	3 (0.7%)	4 (1.0%)	> 0.99
CHF	0	0	
HTN	106 (26.4%)	105 (26.1%)	> 0.99
Chronic steroid use	196 (48.8%)	184 (45.8%)	0.437
> 10% loss of weight/last 6 months	12 (3.0%)	9 (2.2%)	0.659
Bleeding disorder	11 (2.7%)	11 (2.7%)	> 0.99
Preoperative blood transfusion	3 (0.7%)	3 (0.7%)	> 0.99
ASA ≥ 3	131 (32.6%)	150 (37.3%)	0.160
Hypoalbuminemia			0.399
Yes	62 (15.4%)	51 (12.7%)	
Missing	162 (40.3%)	157 (39.1%)	
Anemia			0.534
Yes	89 (22.1%)	90 (22.4%)	
Missing	25 (6.2%)	33 (8.2%)	
Thrombocytopenia			0.423
Yes	6 (1.5%)	7 (1.7%)	
Missing	30 (7.5%)	40 (10.0%)	

DM diabetes mellitus, *COPD* chronic obstructive pulmonary disease, *CHF* congestive heart failure, *HTN* hypertension requiring medications, *ASA* American Society of Anesthesiologists class, *IQR* interquartile range

challenges related to MIS surgery in obese patients [7, 12, 15]. In contrast to what Klos et al. reported, a non-significant difference in both operative time and estimated blood loss between patients with obesity and patients without obesity when open surgery was predominantly utilized [16]. Therefore, although MIS IPAA might have a longer operation time than open IPAA in patients with obesity, this longer operation time does not translate into higher rates of postoperative complications [17].

The high rate of organ space infection in patients with obesity cohort despite MIS is concerning and indirectly highlighting the fact that MIS does not mitigate all the risks related to IPAA surgery. The shortened mesentery associated with obesity might indirectly affect the blood supply and thus increase the leak rates despite maximized reach maneuvers and adequate length to allow successful IPAA completion. [3, 7]. Careful preoperative evaluation of patients' condition and preoperative optimization including weight loss may be beneficial. However, preoperative conditioning also requests correction of potential nutritional deficits (also in obese patients), anemia, and steroid weaning in order to achieve a clinical benefit [18, 19]. Indeed, obesity was found to be an independent risk factor for pouch complications [16], and comparable rates to our results regarding pelvic infection and anastomotic leak for patients with obesity undergoing IPAA have been reported before (18.8% for patients with obesity vs. 8.1% for patients without obesity; p-value < 0.05) [8]. Interestingly, in their study, the higher rate of pelvic infection did not translate into worse long-term outcomes [8]. However, Fazio et al. have shown previously that pelvic sepsis or anastomotic leak were strong predictors of pouch failure [20]. Importantly, organ space infections have a detrimental effect not only on patients but also on healthcare systems by increasing length of hospital stay [21].

Unsurprisingly, patients with obesity had higher rates of different comorbidities. By balancing the baseline confounders, we tried to better understand the impact of MIS by mitigating the impact of these comorbidities. Indeed, after propensity score matching, MIS was not associated with a higher risk of medical complications, mortality, or length of stay, taking into account the differences in baseline confounders. This may highlight the benefit of MIS even in this challenging population. Indeed, the benefit of MIS in patients with obesity or even super obesity undergoing colorectal surgery has been demonstrated before [9].

Table 3 Postoperative complications

	BMI < 30 n = 402	BMI ≥ 30 n = 402	P-value
Any surgical	76 (18.9%)	91 (22.6%)	0.192
SSI	47 (11.7%)	66 (16.4%)	0.053
Superficial SSI	18 (4.5%)	11 (2.7%)	0.256
Deep SSI	5 (1.2%)	4 (1.0%)	> 0.99
Organ/space SSI	**26 (6.5%)**	**52 (12.9%)**	**0.002**
Wound disruption	3 (0.7%)	2 (0.5%)	> 0.99
Systemic sepsis	28 (7.0%)	31 (7.7%)	0.685
Sepsis	26 (6.5%)	25 (6.2%)	0.885
Septic shock	2 (0.5%)	6 (1.5%)	0.287
Need for blood transfusion	22 (5.5%)	28 (7.0%)	0.380
Any medical	40 (10.0%)	37 (9.2%)	0.719
Respiratory complications	3 (0.7%)	7 (1.7%)	0.341
Renal complications	4 (1.0%)	4 (1.0%)	> 0.99
VTE	15 (3.7%)	17 (4.2%)	0.718
MACE	2 (0.5%)	2 (0.5%)	> 0.99
UTI	20 (5.0%)	13 (3.2%)	0.286
Mortality	1 (0.2%)	2 (0.5%)	> 0.99
LOS	6 (4.75–9)	6 (4–9)	0.906

Bold indicates statiscially signficant

SSI surgical site infection, *VTE* venous thromboembolism, *MACE* major adverse cardiovascular events, *UTI* urinary tract infection, *LOS* length of stay

Our study adds to the current understanding of surgical management of patients with ulcerative colitis who have concurrent obesity. Although we could not assess long-term outcomes, surgical case volume, or experience of the surgeons, the present study represents the largest cohort in the literature reporting on the impact of obesity in MIS TPC with IPAA. Additional limitations include the retrospective nature, inability to obtain specifics on preoperative medical therapy (i.e., biologic or other immunosuppressive treatments than steroids), intraoperative complications, or whether the organ space infection is due to an anastomotic leak or other causes. In addition, no information about preoperative prehabilitation including nutritional support [18]. The impact of obesity on short-term outcomes after a two-stage operation could not be assessed due to limitations in the CPT coding. Thus, our study is confined to the group who underwent TPC from the start and the potential benefit of MIS for patients with obesity undergoing MIS three-stage IPAA could not be assessed.

Conclusion

MIS TPC with IPAA can be safely performed in patients with obesity. However, patients with obesity have a 2-fold risk of organ space infection compared to patients without obesity. Loss of weight before MIS IPAA is recommended not only to allow for pouch creation but also to decrease organ space infections.

Declarations

Ethical approval This study utilized a national database that is Health Insurance Portability and Accountability Act (HIPAA) compliant using deidentified patients' information. Therefore, informed consent was not required.

Conflict of interest The authors declare no competing interests.

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