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Impact of body mass index on short-term outcomes following gastric and colorectral cancer surgery

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Abstract

Aim: The present study aims to investigate the effect of high body mass index (BMI) on short-term outcomes and survival in patients following intra-abdominal malignancy surgery.
Materials and Methods: The study was carried out in Ankara University, Department of Surgical Oncology. We retrospectively analyzed the data of patients who underwent gastrectomy and colectomy for malignancy in our clinic between August 2019 and August 2020. BMI was calculated by dividing body weight (kg) by height (m) squared. The patients were classified into two groups as normal (<25.0 kg/m^2) and overweight (≥25 kg/m^2) in terms of BMI.
Results: 158 patients were included in our study. 78 (49.3%) had undergone surgery for gastric cancer and 80 (50.7%) for colorectal cancer. 73 (46.2%) patients were female and 85 (53.8%) male. The mean age was 61.50±13.37. Fifty four (34.2%) patients had BMI <25 kg/m^2 and 104 (65.8%) of them were ≥25 kg/m^2. 57.6% of the patients operated on for gastric cancer and 75.6% for colorectal cancer had high BMI, and the difference between the two groups was statistically significant (p = 0.01). An investigation of relationship between BMI and mortality revealed that 37 with BMI ≥25kg/m^2 and 5 with BMI <25kg/m^2 died. The difference was statistically significant (p<0.001).
Conclusion: BMI is an important factor affecting postoperative morbidity and mortality in patients with gastric and colorectal malignant tumors. In the present study, we show that overweight may be associated with severe postoperative complications and poor prognosis in these patients. We suggest that surgeons be highly aware of BMI to make effective treatment plans in gastric and colorectal cancer cases

Introduction

Gastric cancer is among the most common types of cancer in the world (1). Radical resection and lymph node dissection are the gold standards for curative treatment. Despite advances in technology, most of the cases are still diagnosed late, and the prognosis varies. Therefore, personalized treatment is necessary (2). Colorectal cancers are the third most common type of cancer(3), and obesity is a risk factor for developing the disease (4). Radical resection still remains the most effective type of treatment (5).

Improvements in quality of life may be linked to obesity (6). High BMI has been shown to increase the risk of many cancer types such as colorectal, gastric, breast, and pancreatic (7-11). Overweight and related factors may cause technical challenges in gastric and colorectal cancer surgery (12, 13). In the literature, high BMI is associated with poor postoperative outcomes, such as the increase in the level of complications, operative time, blood loss, wound infection (14-16). Various studies have correlated high BMI with increased complications in patients who underwent gastrectomy for gastric cancer and colectomy for colorectal cancer (17, 18). However, some studies suggest that obesity may not be linked to a higher level of complications (19). So the relationship between obesity and survival remains unclear. While some investigators argue that it is a poor prognostic factor for gastric and colorectal cancers (20, 21), others reject the relationship (22, 23). Our hypothesis in the study is to reveal the negative effects, increased complication rates and survival effects of high body mass index on patients undergoing malignancy surgery. Our study aim is to be more careful in such patients and to be vigilant in terms of complications. The main problem is that the limited types of malignancies we look at do not reflect all of them. The present study investigates the effect of BMI on short- term outcomes and survival in patients who underwent surgery for intra-abdominal cancer malignancy.

Materials and Methods

The study was carried out in Ankara University, Department of Surgical Oncology. We retrospectively analyzed the data of patients who underwent gastrectomy and colectomy for malig-

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nancy between August 2019 and August 2020. (Our study was approved by our Institutional Ethics Committee and the ethics committee approval number is I4-260- 21.) The design of the study is retrospective cohort. We performed total or distal gastrectomy in patients with gastric cancer and colectomy or rectal resection in patients with colorectal cancer. Exclusion criteria were: less than 18 years of age, distant metastasis, a diagnosis other than adenocarcinoma, being operated on in emergency conditions, previous diagnosis of another malignancy, recurrence, peritoneal involvement, and positive cytology. The study population consisted of 158 patients. The sample size was based on the alpha error at 0.05 and a power of 90%. The sample size was calculated using nQuery Advisor 7.0 (Cork, Ireland). We analyzed the demographic and clinicopathological data, postoperative complications and overall survival of the patients by scanning the available electronic files retrospectively. Primary output variables are: BMI, complication, survival, age, gender, cancer type, comorbidity, ASA score, location, technique, hospital and ICU stay, operation time. BMI was calculated by dividing body weight (kg) by height (m) squared. The patients were classified into two groups as normal (<25.0 kg/m^2) and overweight ($\geq$25 kg/m^2) in terms of BMI.

Statistical Analysis

We used SPSS 25.0 (IBM SPSS Statistics 25.0, USA) software package for statistical analysis. Quantitative variables were expressed as mean ± standard deviation and median (minimum-maximum), and qualitative variables as number (percentage). Shapiro-Wilk test and histogram curves were used to check the normality of quantitative data. We analyzed the difference between qualitative variables with two categories in terms of qualitative variables using the Student's t-test for those following normal distribution and the Mann-Whitney U test for the rest. The Chi-squared test was used to evaluate the relationship between two qualitative variables. p$\leq$0.05 value was considered statistically significant.

Results

One hundred and fifty-eight patients were included in our study. 78 (49.3%) had undergone surgery for gastric cancer and 80 (50.7%) for colorectal cancer. 73 (46.2%) patients were female and 85 (53.8%) male. The mean age was 61.50±13.37. Fifty four (34.2%) patients had BMI <25 kg/m^2 and 104 (65.8%) of them were $\geq$25 kg/m^2. 57.6% of the patients operated on for gastric cancer and 75.6% for colorectal cancer had high BMI, and the difference between the two groups was statistically significant (p = 0.01). Mean operative time was 134.65±29.01 minutes, and mean length of stay in hospital was 11.69±8.18 days, and in intensive care, 1.70±1.84 days. All descriptive characteristics are given in Table 1.

BMI was $\geq$ 25kg/m^2 in 73% of female patients and 58.8% in males, and the difference was statistically significant (p = 0.045). 57.6% of the patients operated on for gastric cancer, and 75.6% for colorectal cancer had high BMI. The difference between the two groups was statistically significant (p = 0.01). 23 patients with BMI $\geq$ 25kg/m^2 and 4 with BMI < 25kg/m^2 developed postoperative complications, and the difference was statistically significant (p = 0.020). 21 patients with BMI $\geq$ 25kg/m^2 and 4 with BMI < 25kg/m^2 underwent combined resection. The difference was statistically significant (p = 0.037). Length of stay in hospital and intensive care was longer in patients with BMI $\geq$ 25kg/m^2, which was also statistically significant (p = 0.029 and p = 0.010, respectively). The relationship of BMI with all variables is shown in Table 2.

An investigation of the relationship between BMI and mortality revealed that 37 with BMI $\geq$25kg/m^2 and 5 with BMI < 25kg/m^2 had died. The difference was statistically significant (p < 0.001). The mean survival time of the patients was 9.73±4.89 years. It was 9.12±4.71 among those with BMI $\geq$ 25kg/m^2 and 10.90 ± 5.06 among those with BMI < 25kg/m^2. Additional survival analysis showed that patients with high BMI had poorer survival outcomes, and the difference between the two groups was statistically significant (p = 0.001) (Figure 1).

Table 1. Patient Characteristics

Variables		
Age Mean ± SD		61.50 ± 13.37
Hospital stay(day) Mean ± SD		11.69 ± 8.18
ICU stay(day) Mean ± SD		1.70 ± 1.84
Operation time(min) Mean ± SD		134.65 ± 29.01
Survival	Live	116(73.4)
	Ex	42(25.5)
Gender	Male	86 (53.8)
	Female	73 (46.2)
BMI(kg/m^2)	Male	86 (53.8)
	Female	73 (46.2)
BMI(kg/m^2)	< 25	54 (34.2)
	$\geq$ 25	104 (65.8)
Complication	Yes	27 (17.1)
	No	131 (82.9)
Postoperative complication	Yes	8 (17.6)
	No	150 (5.1)
Combine resection	Yes	25 (15.8)
	No	133 (84.2)
Comorbidity	Yes	60 (38.0)
	No	98 (62.0)
ASA score	1	98 (62.1)
	2	47 (29.7)
	3	13 (8.2)
Location	Gastric	80 (50.6)
	Colorectal	78 (49.4)
Neoadjuvant therapy	Yes	41 (25.9)
	No	117 (74.1)
Technique	Open	38 (35.3)
	Laparoscopy	62 (64.7)
Intraoperative blood transfusion	Yes	22 (13.9)
	No	128 (81.0)
Postoperative blood transfusion	Yes	31 (19.6)
	No	127 (80.4)

ICU: intensive care unit; BMI: body mass index; SD: standard deviation

Table 2. Relationship between BMI and Variables

Variables		BMI		
		< 25kg/m^2 (n = 54)	≥ 25kg/m^2 (n = 104)	p value
Gender, n(%)	Male	35 (64.9)	50 (48.1)	0.045
	Female	19 (35.1)	54 (51.9)	
Comorbidity, n(%)	No	34 (62.9)	64 (61.6)	0.861
	Yes	20 (37.1)	40 (38.4)	
Location, n(%)	Gastric	35 (64.9)	45 (43.3)	0.010
	Colorectal	19 (35.1)	59 (56.7)	
Postoperative complication, n(%)	No	50 (92.6)	81 (60.0)	0.020
	Yes	4 (7.4)	23 (40.0)	
Technique, n(%)	Open	14 (25.9)	46 (44.3)	0.025
	Laparoscopy	40 (74.1)	58 (55.7)	
Neoadjuvant therapy, n(%)	No	42 (77.8)	75 (72.2)	0.441
	Yes	12 (22.2)	29 (27.8)	
AFP(ng/ml)	Normal	50 (92.6)	102 (98.1)	0.087
	High	4 (7.4)	2 (1.9)	
Ca19-9(U/ml)	Normal	52 (96.3)	92 (88.5)	0.1
	High	2 (3.7)	12 (11.5)	
CEA(ng/ml)	Normal	27 (50)	57 (54.9)	0.566
	High	27 (50)	47 (45.1)	
Combine resection, n(%)	No	50 (92.6)	83 (79.9)	0.037
	Yes	1 (1.8)	7 (6.7)	
Postoperative mortality, n(%)	No	53 (98.2)	97 (93.3)	0.185
	Yes	1 (1.8)	7 (6.7)	
Mortality	No	49 (90.8)	67 (96.5)	<0.001
	Yes	5 (9.2)	37 (3.5)	
Hospital stay(day) Mean±SD		10.01 ± 4.63	12.54 ± 9.47	0.029
Operation time(min) Mean±SD		137.31 ± 21.71	133.78 ± 31.88	0.281
ICU stay(day) Mean±SD		1.16 ± 0.37	1.99 ± 2.21	0.010
Age, n(%) Mean±SD		58.75 ± 12.51	63.05 ± 13.64	0.063

AFP: alfa fetoprotein; CEA: carcinoembryonic antigen; ICU: intensive care unit; SD: standard deviation

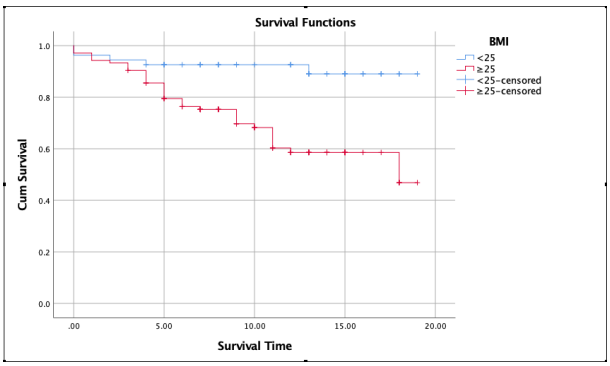

Figure 1. Body Mass Index-Survival Analysis

Furthermore, the patients who underwent laparoscopic surgery, had high levels of CEA and Ca19-9, and developed complications showed worse survival ($p < 0.001$, $p < 0.021$, $p < 0.024$, $p < 0.001$, respectively). Kaplan-Meier analysis results are given in Table 3.

Discussion

This study aimed to evaluate patients' outcomes following colon, rectum, and stomach resection in terms of BMI, focusing on postoperative complications and survival. BMI is a clinical parameter that is widely used due to its ease of calculation. The effects of BMI on outcomes following gastric and colorectal malignancy surgery had been investigated before but remain controversial (24-27).

In the present retrospective study involving 158 patients, the rates of postoperative complications and mortality were higher among overweight patients, and the difference was statistically significant. However, we had performed a higher number of combined resections among overweight patients, and high BMI was an independent prognostic factor. Various earlier studies focusing on BMI's impact on intraoperative conditions had as-

Table 3. Survival analysis results

Variables		Survival 1 year (%)	Survival time (month)	p value
General		70.2	14.94	-
BMI	<25kg/m^2	92.6	17.49	0.001
	≥25kg/m^2	58.6	13.63	
Gender	Male	68.3	14.71	0.904
	Female	70.9	15.03	
ASA score	1	73.6	15.41	0.172
	2	69.6	14.84	
	3	46.2	10.23	
Comorbidity	No	73.6	15.41	0.251
	Yes	64.5	14.23	
Location	Gastric	68.8	14.62	0.517
	Colorectal	71.3	12.51	
Neoadjuvant therapy, n(%)	No	69.4	14.88	0.866
	Yes	71.9	15.05	
Technique	Open	48.8	10.70	<0.001
	Laparoscopy	83.8	16.74	
Combine resection	No	70.9	15.06	0.657
	Yes	66.5	11.77	
Ca19-9(U/ml)	Normal	72.6	15.27	0.024
	High	45.1	8.77	
Complication	No	77.0	15.94	<0.001
	Yes	40.1	10.40	
CEA(ng/ml)	Normal	77.6	16.18	0.021
	High	62.0	13.56	

BMI: Body Mass Index; CEA: Carcinoembryonic antigen

sociated high BMI with increased blood loss, insufficient lymph node dissection, and prolonged operative time (24, 28, 29). Yet, other studies had argued the contrary (30, 31). The present study also showed no relationship between BMI and blood loss, intraoperative blood transfusion, or operative time. We think there is no prolongation of operative time, especially in patients with high BMI, thanks to the latest laparoscopic techniques. Normally, a thick abdominal wall and increased adipose tissue mass pose challenges in open surgery, while the effect of these negative factors is minimized in laparoscopic surgery.

There are also contradictory results in the literature regarding postoperative complications. Kulig et al. showed that patients with high BMI tended to develop more intra-abdominal abscess and cardiopulmonary complications (32). Other studies reported a higher rate of wound and surgical site infections (28, 33). This may be due to inadequate oxygen supply to excessive white adipose tissue. Failure to administer adequate postoperative antibiotic doses due to overweight may also play a part in this regard. In addition, anastomotic leaks due to tension are reported to be more common in patients with a higher mesenteric thickness (24). We think that complications may occur due to a weakened immune system, technical difficulties during the surgery, and associated comorbidities. Especially in low rectal cancers, the pelvis may be narrower in patients with high BMI, rendering manipulation, mobilization, ligation, and transection more difficult. However, some studies suggest no relationship between postoperative complications and BMI (26, 34). We attribute the contradiction in these results to data collection errors due to retrospective study designs, differences in complication definitions, and, in some studies, limited population with high BMI, resulting in low statistical power. In the present study, postoperative complications (atelectasis, wound infection, anastomotic leak, pleural effusion) and combined organ resections were more common in overweight patients, and the difference was statistically significant (p = 0.02 and p = 0.037, respectively).

Some studies have argued that increases conversion from laparoscopic surgery to open surgery in patients with high BMI, leading surgeons to avoid laparoscopy in such cases (12, 35). The present study does not corroborate that. None of the patients in our study population required conversion to open, which may be because a highly experienced team performed the surgery. In fact, our patients who underwent open surgery had a poorer prognosis, and the difference was statistically significant (p<0.001). We think that laparoscopic technique is superior to the open technique in overweight patients. In our study, patients with high BMI had longer stay in hospital and intensive care (p = 0.029 and p = 0.010, respectively). There are other studies in the literature with similar conclusions (36). The higher rate of postoperative complications is also supportive of that (16). Patients with high BMI tend to have longer recovery periods.

Some studies in the literature have reported no statistically significant relationship between BMI and survival (32, 37, 38). Others have reported a better prognosis in mildly obese patients, calling this phenomenon "the obesity paradox" (39). Present study has shown a poorer prognosis in obese patients regarding short-term outcomes (p = 0.001). We believe that in obese patients, excessive abdominal fat may impede lymph node dissection and even accurate pathological assessment, and a higher rate of postoperative complications may lead to poor prognosis. Regarding other factors except for BMI, our study has shown that patients who underwent open surgery and had higher levels of CEA and Ca19- 9 had poorer survival. Also, patients who developed postoperative complications had worse short-term outcomes in terms of survival.

Limitations

Our study's limitations are the single-center retrospective design, small sample size, short follow-up time, and lack of postoperative BMI values.

Conclusion

In sum, BMI is an important factor affecting postoperative morbidity and mortality in patients with gastric and colorectal malignant tumors. In the present study, we have shown that overweight may be associated with more severe postoperative complications and poorer prognosis in these patients. We suggest that surgeons be highly aware of BMI to make effective treatment plans in gastric and colorectal cancer cases. Further studies, especially with a prospective design, will prove invaluable for the relevant literature on gastric and colorectal cancer.

Ethical Approval

The study protocol was reviewed and approved by Ankara University Ethical Committee. The study was performed in accordance with the principles of the Declaration of Helsinki. IRB number : I4-260-21

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