Impact of obesity on outcomes in the management of localized adenocarcinoma of the esophagus and esophagogastric junction

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Objective: Obesity trends in the Western world parallel the increased incidence of adenocarcinoma of the esophagus and esophagogastric junction. The implications of obesity on standard outcomes in the management of localized adenocarcinoma, particularly operative risks, have not been systematically addressed.

Methods: This retrospective analysis of prospectively collected data included 150 consecutive patients (36 [24%] obese [body mass index > 30] and 114 nonobese), of whom 43 were normal weight (body mass index 20–25) and 71 were overweight (body mass index 25–30). Eighty-one patients underwent multimodal therapy. The primary end points were in-hospital mortality and morbidity, and median and overall survivals.

Results: Thirty of 36 obese patients (84%) had a body mass index from 30 to 35. Compared with those of the nonobese cohort, obese patients had significantly increased respiratory complications ($P = .037$), perioperative blood transfusions ($P = .021$), anastomotic leaks ($P = .009$), and length of stay ($P = .001$), but no difference in mortality ($P = .582$) or major respiratory complications ($P = .171$). Median and overall survivals were equivalent ($P = .348$) in both groups.

Conclusions: Obesity was associated with increased respiratory complications and anastomotic leak rates but not with major respiratory complications, mortality, or survival. These outcomes suggest that the added risks of obesity on standard outcomes in esophageal cancer surgery are modest and should not independently have a significant impact on risk assessment in esophageal cancer management.

The pattern of esophageal cancer in Europe and North America has changed dramatically in recent decades, with a marked increase in the incidence of adenocarcinoma of the esophagus and esophagogastric junction.¹ The explanation for this increase is unclear, but several risk factors, including chronic gastroesophageal reflux disease, obesity/diet, and *Helicobacter pylori* eradication, are plausibly linked with this emerging trend.^{1,2} Increasing epidemiologic evidence strongly links obesity and both the incidence of adenocarcinoma at these sites and death from this cancer.³⁻⁹

Consequently, the esophageal surgeon today is presented increasingly with the challenge of managing obese patients with adenocarcinoma of the esophagus or junction. The risk of operative mortality is up to 10%, with an approximate 50% risk of morbidity. Some evidence suggests that these risks may be further increased by neoadjuvant therapy, particularly combination chemotherapy and radiation therapy.¹⁰⁻¹² The management of localized disease has a major impact on quality of life over several months.^{13,14} Studies of the implications of obesity, defined by World Health Organization criteria¹⁵ as a body mass index (BMI) of greater than 30 kg/m², are therefore important, particularly with regard to risk assessment for esophageal

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Abbreviations and Acronyms

ARDS = acute respiratory distress syndrome

BMI = body mass index

TRG = tumor regression grade

surgery. A combination of factors, including the association of obesity with existing comorbidities and medical complications, the complexity and duration of anesthesia and surgery, and insulin resistance, hormonal alterations, and chronic inflammation,¹⁶ permit the speculative thesis that obesity may increase the incidence of complications.

The principal risks after esophagectomy relate to respiratory complications. Intuitively, obese patients may be at higher risk, because pulmonary function in obese patients is characterized by reductions in functional residual capacity, expiratory reserve volume, and alveolar oxygen partial pressure, and an increase in the alveolar–arterial oxygen difference.^{17,18} The obese patient may consequently be more vulnerable to significant hypoxia from common postoperative problems, such as atelectasis. Abnormalities in control of breathing are also common, obstructive sleep apnea may occur in up to 40% of men with morbid obesity, and obstructive hypoventilation syndrome may also occur.¹⁹ Intraoperative or postoperative ventilation may be impaired by reduced compliance of the lung and chest wall and an increase in airway resistance. Moreover, when ventilator support is required postoperatively, weaning may be delayed because of this reduced chest wall compliance, and obese patients compared with nonobese patients have an up to a 5-fold increase in oxygen uptake when changing from positive pressure ventilation to spontaneous breathing as a result of the increased work of breathing.^{16,17}

Notwithstanding theoretic concerns, there is currently no reported systematic assessment of the relationship between obesity and standard outcomes in the management of localized cancer of the esophagus and esophagogastric junction. We report the experience of this unit and highlight the largely equivalent outcomes at this time between obese and nonobese cohorts.

Materials and Methods

We performed a retrospective analysis of a prospectively compiled database of patients with histologically proven adenocarcinoma of the esophagus or esophagogastric junction who underwent surgery in St James Hospital, Dublin, between January of 1998 and December of 2005. This study was approved by the hospital's ethics committee. Severely malnourished patients with a BMI less than 20 kg/m² (n = 5) and patients who underwent an emergency esophagectomy were excluded from the analysis. Preoperative weight and height were used to calculate BMI. The preoperative medical comorbidities and presenting symptoms were noted, as well as the reported and actual weight loss at time of diagnosis.

The patients' age, cigarette and alcohol consumption, performance status, initial routine blood results, and pulmonary function test scores were also noted. Obesity was defined as a BMI greater than 30 kg/m² per World Health Organization and National Institutes of Health Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults.^{15,20}

All patients had localized disease according to clinical, endoscopic, and computed tomography assessments. Endoscopic ultrasound was not routinely used. Fluorodeoxyglucose–positron emission tomography scanning has been routinely used since 2004. By using computed tomography criteria, the mediastinal, left gastric, and celiac lymph nodes were classified as N1 (invaded) if the maximal transverse diameter of these nodes was larger than 1 cm. Localized disease was defined as T₁₋₃, N₀₋₁. All tumors of the esophagogastric junction were assigned as type I, II, or III, per Siewert and Stein.²¹ Type I is adenocarcinoma of the distal esophagus, usually arising in specialized intestinal metaplasia; type II is a true adenocarcinoma of the cardia arising immediately at the esophagogastric junction; and type III is a subcardial gastric carcinoma infiltrating the esophagogastric junction and distal esophagus from below.

Patients with type I and II tumors were considered for multimodal therapy involving a regimen of chemotherapy (cisplatin and fluorouracil) and radiation therapy (40–44 Gy in 15–20 fractions) as previously described.²² The majority (97%) of patients undergoing an esophagectomy had a thoracotomy as a component of their surgical management, combined with the following: an abdominal and neck exploration (3-stage) for mid and upper-esophageal cancers or cancer arising in long-segment Barrett's esophagus, an abdominal exploration (2-stage) for most lower third and junctional tumors, or a total gastrectomy for junctional tumors with significant gastric extension (type III). All intrathoracic and cervical anastomoses were performed with interrupted single-layer 3-0 polydioxanone (Ethicon, Dublin, Ireland). A 2-field lymphadenectomy (abdominal and thoracic) was performed in all transthoracic cases. The length of the operation, intraoperative blood loss, and blood products given were all noted.

Unit protocol states that all patients receive epidural analgesia, be extubated immediately after surgery, and be managed in a high-dependency unit. All patients are fed enterally through a needle catheter jejunostomy from 12 hours postoperatively. A Gastrografin contrast study is performed routinely on day 8 postoperatively before initiating oral fluids. Throughout the hospitalization and at the 3-month follow-up, a dietitian monitored nutritional intake, complications, and body weight changes.

All complications from surgery to discharge from hospital were prospectively documented. Respiratory failure was defined as the requirement for mechanical ventilation more than 24 hours after surgery. Acute respiratory distress syndrome (ARDS) and multiple organ failure were defined per Bone and colleagues,²³ sepsis required evidence of systemic inflammatory response syndrome with microbiological evidence of infection, and pneumonia required positive sputum cultures or clear clinical and radiographic evidence of consolidation.

Major respiratory complications for the purpose of this analysis were defined as pneumonia, empyema, respiratory failure, and

ARDS. Any patient who experienced more than 1 major complication was only included in the analysis once.

The tumor stage was defined according to the TNM staging system and the American Joint Committee on Cancer classification.²⁴ Fat-clearing methods were not used to increase lymph node yield. The definition of a curative resection was that all visible tumor was removed and that proximal, distal, and circumferential margins were free of tumor on histologic examination. In patients undergoing neoadjuvant therapy, the extent of residual carcinoma in the esophagectomy specimen was assigned to 1 of 5 tumor regression grade (TRG) categories per Mandard and colleagues:²⁵ TRG1 represents fibrosis within the esophageal wall with no identifiable residual cancer cells, pathological complete response; TRG2 represents rare residual cancer cells scattered throughout the fibrosis; TRG3 represents an increase in the number of residual cancer cells, but fibrosis still predominant; TRG4 represents residual cancer cells outgrowing fibrosis; and TRG5 represents a complete absence of regression change. A TRG of 1 or 2 is deemed a good response, and a TRG of 3 to 5 is deemed a poor response.

Statistical Methods

Statistical analysis was performed using the Statistical Package for the Social Sciences Version 11.0 for Windows (SPSS Inc, Chicago, Ill). Analysis of variance was used to identify significant differences between BMI categories. Postoperative complications were compared using univariate chi-square tests. The primary comparison was between obese and nonobese cohorts, but some comparisons were also made between 3 cohorts: obese, overweight, and normal weight. Multinomial logistic regression models were used to account for potential confounding factors associated with postoperative complications. The models included age, sex, heavy alcohol intake, and current smokers. We obtained hazard ratios and 95% confidence interval levels from the models for the obese and nonobese groups. Actuarial survival was calculated from the date of first treatment by the Kaplan–Meier method, and comparisons between the groups were made by the log–rank test.

Results

Patient Demographics

During this period, resection for localized disease with curative intent (anticipated clear margins, R0) was undertaken in 150 patients, 81 of whom (54%) had neoadjuvant chemoradiation therapy before surgery according to the unit protocol. Forty-three patients (29%) were of normal weight (BMI 20–25 kg/m²), with a weight range between 50 and 85 kg; 70 patients (47%) were overweight (BMI 25–30 kg/m²), with a weight range of 80 and 130 kg; and 36 patients (24%) were obese (BMI > 30 kg/m²), with a weight range between 80 and 130 kg. The median BMI was 27 kg/m². In the obese group, 30 patients (83%) had a BMI between 30 and 35 kg/m² (80–115 kg), 4 patients (11%) had a BMI between 35 and 40 kg/m² (101–125 kg), and 2 patients (5%) had a BMI greater than 40 kg/m² (131 kg) (Table 1).

The clinical pattern of presentation was similar in both groups. There was no significant difference between obese

TABLE 1. Demographics of obese and nonobese groups

Demographic details	Nonobese (n = 114)	Obese (n = 36)	P value
Sex: male/female	98/16	31/5	.216
Age: median (range), y	62 (37–79)	62 (29–79)	.521
Symptoms			
Dysphagia			
Heartburn	81 (71)	29 (81)	.183
Regurgitation	36 (32)	11 (31)	.541
Weight loss > 10%	39 (34)	12 (33)	.546
History of GERD > 1 y	34 (33)	4 (13)	.059
	31 (27)	10 (28)	.562
Smoking and alcohol			
Never smoked	41 (36)	7 (20)	
Ex-smoker (>1 y)	46 (40)	22 (61)	
Current smoker	27 (24)	7 (19)	.076
Heavy alcohol	20 (18)	9 (25)	.352
Comorbid disease and performance status			
Cardiovascular	35 (31)	17 (47)	.033
Respiratory disease	19 (17)	8 (22)	.299
Type II diabetes	9 (8)	2 (6)	.258
Karnovsky > 90%	108 (96)	34 (95)	.367
ECOG: fully active	79 (70)	26 (73)	.345
ASA grade I or 2	95 (87)	34 (94)	.322
Pulmonary function tests			
FEV ₁	3.1 (1–5.5)	2.7 (1.1–4.1)	.046
FVC	4.0 (2.0–6.4)	3.8 (1.7–5.9)	.297
FEV ₁ /FVC ratio	79 (42–94)	74 (53–89)	.014

GERD, Gastroesophageal reflux disease; ECOG, Eastern Cooperative Oncology Group; ASA, American Surgical Association; FEV₁, forced expiratory volume in 1 second; FVC, forced vital capacity.

and nonobese patients in known type 2 diabetes, respiratory disease, or performance status. The incidence of cardiovascular disease was influenced by BMI; 7 of 43 patients (16%) with a BMI between 20 and 25 kg/m² had a history of cardiovascular disease, compared with 28 of 70 patients (40%) with a BMI between 25 and 30 kg/m² and 17 of 36 patients (47%) with a BMI more than 30 kg/m² ($P = .003$).

In obese patients, preoperative forced expiratory volume in 1 second ($P = .046$) and the forced expiratory volume in 1 second/forced vital capacity ratio ($P = .014$) were significantly inferior compared with those of the nonobese group. This did not relate to tobacco consumption; the highest percentage of current smokers (40%) was in the normal weight groups compared with the overweight (14%) and obese (19%) groups ($P = .042$).

Treatment Characteristics

There was no significant difference in esophagogastric junction classification among the BMI categories. Some 67% of obese patients received multimodal therapy compared with 50% of nonobese patients ($P = .018$). The majority of

TABLE 2. Tumor type, treatment details, and pathology

	Nonobese (n = 114)	Obese (n = 36)	P value
Tumor location			
Lower:			
Type 1	53 (47)	11 (31)	.290
Type 2	42 (38)	21 (60)	
Type 3	17 (15)	3 (9)	
Mid	2 (2)	0	
Associated Barrett's	50 (44)	20 (56)	.180
Type of surgery			
2-stage esophagectomy	96 (84)	33 (92)	.486
3-stage esophagectomy	14 (12)	1 (3)	
Transhiatal	3 (3)	1 (3)	
Thoracoabdominal	2 (2)	1 (3)	
Multimodal therapy	57 (50)	24 (67)	.018
Pathology			
Stage 0/1	22 (19)	11 (31)	
Stage 2	39 (34)	16 (44)	
Stage 3	52 (46)	9 (25)	.013
Node positive	70 (61)	20 (53)	.082
R0	93 (84)	29 (83)	.257
No. of nodes analyzed	15 (5–46)	10 (4–28)	.008
Response to neoadjuvant therapy (n = 81)			
TRG 1 and 2	26 (45)	10 (42)	.495
TRG 3, 4, and 5	31 (55)	14 (58)	
Pathologic complete response	12 (21)	3 (12)	.425

TRG, Tumor regression grade.

patients in both groups underwent a 2-stage esophagectomy (Table 2).

Pathologic Analysis

The R0 resection rate was 83% and 84% in the obese and nonobese groups, respectively ($P = .198$). In patients undergoing multimodal therapy, the complete pathologic response rate was 12% in the obese group compared with 21% in the nonobese group ($P = .425$), and there were no differences between groups in terms of achieving a major histomorphologic response (TRG1 or 2) at the primary site, observed in 42% and 45% in the obese and nonobese groups, respectively ($P = .495$). In this cohort, nonobese patients had more advanced cancer according to pathologic stage, with 46% of patients presenting with stage 3 disease versus 25% of obese patients ($P = .013$). There was no significant difference in nodal status; the majority of patients were node-positive: 53% in the obese group versus 61% in the nonobese group ($P = .082$). The median nodal yield was significantly ($P = .008$) greater in the nonobese group at 15 (5–46), compared with 10 (4–28) in the obese patient. Nonobese patients had a significantly greater number of positive nodes than obese patients: 3 (0–25) versus 1

TABLE 3. In-hospital postoperative morbidity and mortality

	Nonobese (n = 114)	Obese (n = 36)	P value
Mortality	7 (6)	2 (6)	.582
Sepsis	12 (11)	5 (14)	.386
All respiratory complications	43 (38)	21 (58)	.037
Major respiratory complication*	21 (19)	10 (28)	.171
Respiratory failure	12 (11)	2 (6)	.299
ARDS	7 (6)	2 (6)	.630
Pneumonia	15 (13)	4 (11)	.502
Empyema	0	2 (6)	.057
Pleural effusion	27 (24)	15 (42)	.032
Atelectasis	9 (8)	5 (14)	.121
Thromboembolism	3 (3)	1 (3)	.436
Major wound complications	3 (2)	0	.760
Arrhythmia	13 (11)	7 (19)	.168
Anastomotic leak	2 (2)	5 (14)	.009
Renal dysfunction	9 (8)	2 (6)	.482
Blood products†			
0	64 (58)	13 (39)	.021
1–2 units	38 (34)	12 (36)	
>2 units	8 (7)	8 (24)	

ARDS, Acute respiratory distress syndrome. *Number of patients with a major respiratory complication (ie, pneumonia, respiratory failure, ARDS, or empyema). †Blood products given intraoperatively or within 48 hours postoperatively.

(0–8) ($P = .037$). Barrett's epithelium was present in 56% of resected specimens in the obese group and 44% in the nonobese group ($P = .180$).

Surgery and In-hospital Complications

There was no significant difference ($P = .150$) between the mean duration of surgery in the obese group (350 minutes) and nonobese group (320 minutes). The use of blood products intraoperatively and in the first 48 hours after surgery in the obese group ($P = .021$) was increased, with 24% of patients requiring over 2 units of blood compared with 7% in the nonobese group (Table 3).

In-hospital mortality was 6% in both groups. Twenty-one of 36 obese patients (58%) had a respiratory complication, compared with 43 of 114 nonobese patients (38%) ($P = .037$); however, there was no significant difference between obese and nonobese groups in major respiratory complications, including pneumonia ($P = .502$), ARDS ($P = .630$), and respiratory failure ($P = .299$). There were 2 cases of empyema, both in the obese group ($P = .057$). An anastomotic leak (3 radiologic and 2 clinical) developed in 5 patients in the obese group, compared with 1 clinical and 1 radiologic leak in the nonobese group ($P = .009$). All were managed nonoperatively, and 1 clinical leak in both groups was managed with endoprosthesis. There were no significant differences between groups with respect to venous thromboembolism ($P = .436$), major wound problems ($P =$

TABLE 4. Relative hazard ratios for obesity and postoperative complication

	<i>P</i> value	OR	95% CI
All respiratory complications	.014	2.6	1.2–5.9
Major respiratory complications	.283	2.7	1.1–6.4
Pleural effusion	.019	2.7	1.1–6.4
Anastomotic leak	.006	11	2.0–61.7

OR, Odds ratio; CI, confidence interval. Adjusted for age, sex, heavy alcohol intake, and current smokers.

.760), arrhythmias ($P = .168$), and renal dysfunction ($P = .482$). The median stay in the high-dependency unit postoperatively was 4 days (0–14 days) in the obese group compared with 4 days (0–32 days) in the nonobese group ($P = .937$). The median hospital stay was significantly ($P = .001$) greater at 23 days (13–94 days) in the obese group compared with 18 days (1–61 days) in the nonobese group.

On multivariate analysis (Table 4), obese patients were 2.6 times more likely to have any respiratory complication ($P = .014$), 2.7 times more likely to have a pleural effusion ($P = .019$), and 11 times more likely to have an anastomotic leak ($P = .006$) than nonobese patients.

Postoperative Nutrition

All patients were nutritionally supported via a feeding jejunostomy in the postoperative period. The median duration of postoperative nutrition support (full feeding or overnight feeding) was 16 days (10–80 days) in the obese group and 15 days (2–53 days) in the nonobese group ($P = .128$). Obese patients lost more weight postoperatively as inpatients compared with nonobese patients (4.7 [0–26] kg vs 2.8 [0–14] kg; $P = .048$).

Survival

At a median follow-up of 39 months, the median survival (Figure 1) in the obese group was 27 months, compared with 25 months in the nonobese group ($P = .348$). The 1, 3, and 5-year survivals were 75%, 46%, and 46%, respectively, in the obese group, and 75%, 34%, and 22%, respectively, in the nonobese group.

Discussion

Obesity, defined as a BMI greater than 30 kg/m², has increased in incidence in the developed world in the last decade. Approximately 30% of the population are obese in the United States, and more than 100,000 operations were performed for morbid obesity in 2004.^{26,27} The increased incidence of adenocarcinoma of the esophagus and esophagogastric junction in recent decades parallels the increasing prevalence of obesity. In an Irish cohort we recently reported that 82% of patients with adenocarcinoma of the

esophagus or esophagogastric junction were overweight or obese, and that obesity in males was associated with a 4-fold increase risk of adenocarcinoma.⁸ The explanation for this association is unclear. One possible mechanism links the typical male central adiposity with chronic gastroesophageal reflux disease, both of which are independently associated with adenocarcinoma of the esophagus and junction.²⁸ In addition to a mechanical link, the pleiotropic properties of the adipocyte have come under scrutiny, because adipocytes from central fat may have endocrine, paracrine, and immunologic properties.²⁹ This may be manifested in the metabolic syndrome, which is a constellation of atherogenic dyslipidemia, elevated blood pressure, and elevated blood glucose associated with insulin resistance. The proinflammatory response associated with central adiposity and the metabolic syndrome may, at least theoretically, promote inflammation and tumorigenic pathways that are relevant to esophageal adenocarcinoma and other tumor types.¹⁶

Surgery for esophageal cancer is associated with a significant risk of morbidity and mortality, and has a major impact on quality of life.¹ A recent review of 70,000 patients reported a mortality of 6.7% between 1990 and 2000.³⁰ The combined Veterans Administration experience for the same period reported a major morbidity rate of approximately 50% and a mortality rate of 10%.¹⁰ In the United Kingdom, McCulloch and colleagues³¹ reported a 12% in-hospital mortality rate from a multicenter series. The recent advent of multimodality regimens, particularly neoadjuvant combination chemotherapy and radiation therapy, may further increase operative risks.^{11,12} It is unassailable that there is no common elective cancer surgery that carries the same risks. In an era of risk stratification and informed consent, data on the impact of obesity on outcomes after esophagectomy are increasingly important, and to our knowledge this is the first report specifically addressing the relationship of obesity to the standard outcome indicators of an esophageal unit.

In this study, no increase in in-hospital mortality was observed in the obese cohort. Respiratory complications were rigorously recorded, and an increased incidence of complications was observed in the obese cohort. There was, however, no increase in the more major complications of postoperative pneumonia, respiratory failure, or ARDS in the obese group. The incidence of anastomotic leaks was increased in the obese group; however, the incidence of clinically evident leaks was not significantly different. The incidence of anastomotic leak was low (3%), compared with the reported incidence of up to 10% post-esophagectomy.^{32,33} On univariate analysis, obesity was the only factor associated with anastomotic leak, and there was no relationship to incidence and age, sex, American Surgical Association grade, smoking, or alcohol use. Obesity was associated with the risk of anasto-

Obese median survival = 29 months

Non obese median survival = 25 months

Non-Obese

Survival time	No at Risk	Deaths	% Survival
0 year	114	0	100%
1 year	81	23	75%
3 years	21	36	34%
5 years	10	7	22%

Obese

Survival time	No at Risk	Deaths	% Survival
0 year	36	0	100%
1 year	26	8	75%
3 years	11	9	46%
5 years	6	0	46%

Figure 1. Survival.

motric leak after resection and primary anastomosis for left-sided colonic emergencies.³⁴ The factors involved in the increased leaks observed in the obese group in this study are unclear, but we speculate that the dependence of touch and judgment rather than clear visibility of the right gastroepiploic vessels, as well as increased tension of the conduit in the high thorax or the cervical site, may compromise the vascularity of the gastric anastomotic site. Other factors, such as diabetes and cardiovascular disease, may also be contributory, but this was not evident in this analysis.

The concern that obese patients would have a higher incidence of wound infections and dehiscence could not be verified, and the incidence of clinical venous thromboembolism was low in this study in which all patients received prophylactic low molecular weight heparin. Blood transfu-

sion requirements were significantly increased in the obese group, and obesity was associated with a significantly longer duration of postoperative hospital stay.

Esophagectomy is associated with significant metabolic, endocrine, and immunoinflammatory changes. A similar spectrum of response is seen after major blunt trauma. In studies of patients with blunt trauma, however, and in contrast with this study, Smith-Choban and colleagues³⁵ reported a 42% mortality in obese patients versus 7% for nonobese patients, and respiratory failure as the result of ARDS was the primary cause. In a study by Neville and colleagues³⁶ on 242 patients admitted to the intensive care unit after blunt trauma, 62 were obese and the odds ratio of mortality was 5.7 compared with the nonobese cohort. In a study of patients undergoing liver transplantation, obesity

was associated with an increased incidence of multiple organ failure.³⁷ The lack of major added risks associated with obesity in this study is consistent with reports of equivalent complication rates in obese and nonobese patients undergoing cardiac surgery, in which the increased risk of complications seems to be evident only in patients with extreme obesity (BMI > 40 kg/m²).³⁸ Only 2 patients in this study had a BMI greater than 40 kg/m²; both patients had sleep apnea and 1 patient had obesity hypoventilation syndrome, but both survived without major complications. It is clear that risk assessment in the morbidly obese patient cannot be inferred from this study of predominantly patients with a BMI from 30 to 35 kg/m².

Frequent symptoms of reflux are associated with increased risks of Barrett's esophagus, and these risks are substantially elevated by obesity and smoking.³⁹ In a population-based study³⁹ in obese patients (BMI > 30), the risk of Barrett's esophagus was minimal with no reflux symptoms (odds ratio: 0.7 95% confidence interval 0.2–2.4) and increased dramatically with weekly reflux symptoms (odds ratio: 34.4 95% confidence interval 6.3–188). There was no difference in the reported incidence of gastroesophageal reflux disease in this population, which may explain the lack of association between obesity and Barrett's esophagus. This study also addressed the standard oncologic indicators, and there was no differences in RO resection rate, tumor response rate, and survival. Nodal yield was less in the obese cohort, perhaps reflecting the lack of routine fat-clearing mechanisms by pathologists.

Limitations

The limitations of the study are acknowledged, particularly the retrospective nature of the analysis. Prospective study in this unit now encompasses assessment of the metabolic syndrome, comprehensive respiratory physiology analysis pretreatment, documentation on intraoperative and early postoperative dynamics in respiratory physiology, and studies of immune function and metabolism in the perioperative period. Underweight patients (BMI < 20 kg/m²) were also excluded because of the small number (n = 5) of the cohort and the fact that they represent a high-risk group. When all patients were included and the population was divided into quintiles or tertiles, a significant association of the highest quintile or tertile with anastomotic leaks and respiratory complications remained evident (data not shown).

Conclusions

This study shows that obese patients undergoing surgical or multimodality management of localized adenocarcinoma of the esophagus or esophagogastric junction have a longer hospital stay, an increased incidence of respiratory complications and radiologic anastomotic leaks, and greater requirements for blood products compared with nonobese patients. There was no difference in mortality or major

complications, and the cancer survival outcomes are equivalent. Risk stratification is the ultimate motivation for establishing complication rates in obese patients undergoing esophageal surgery, and this study shows that surgery was undertaken in an obese population, predominantly patients with a BMI between 30 and 35 kg/m², with no major increased risk of serious morbidity or mortality.

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