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Impact of body mass index on perioperative outcomes and survival after resection for gastric cancer

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ABSTRACT

Background: Among patients undergoing resection for gastric cancer, the impact of body mass index (BMI) on outcomes is not well understood. We sought to define the impact of non-normal BMI on short- and long-term outcomes after gastric cancer resection.

Methods: We identified 775 patients who underwent gastrectomy for adenocarcinoma between 2000 and 2012 from the multi-institutional US Gastric Cancer Collaborative. Clinicopathologic characteristics, operative details, and oncologic outcomes were collected, and patients were stratified according to BMI.

Results: Most patients in the cohort were classified as having normal BMI ($n = 338$, 43.6%), followed by overweight ($n = 229$, 29.6%), obese ($n = 153$, 19.7%), and underweight ($n = 55$, 7.1%). After stratifying by BMI, there were no significant differences in the incidence of postoperative blood transfusions, perioperative morbidity, postoperative infectious complications, length of stay, perioperative 30-d in-hospital death, or readmission across groups (all $P > 0.05$). BMI did not impact overall or recurrence-free survival after stratifying by stage (all $P > 0.05$). However, underweight patients with low preoperative albumin levels had worse overall survival (OS) compared with that of patients of normal BMI.

Conclusions: BMI did not impact perioperative morbidity, recurrence-free, or OS in patients undergoing gastric resection for adenocarcinoma. Underweight patients with BMI <18.5 kg/m^2 and low preoperative albumin levels, however, had a significantly

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decreased OS after gastrectomy for cancer. These high-risk patients should have their nutritional status optimized both before and after gastrectomy in an attempt to modify this risk factor and, in turn, achieve better outcomes.

1. Introduction

Gastric cancer is the fourth most common malignancy worldwide but only the 15th most common cancer in the United States [1—3]. Differences in the prevalence of various risk factors for the development of gastric adeno-carcinoma may be partially responsible for this wide variation of incidence and include diet, tobacco, and alcohol use, as well as *Helicobacter pylori* infection. Although relatively uncommon, in 2013, over 21,000 US patients will be newly diagnosed with gastric cancer resulting in nearly 11,000 deaths [1—3]. Surgical resection, often in combination with perioperative chemotherapy and/or radiotherapy, offers the best hope for long-term survival [4,5]. Although prognosis after gastric resection heavily depends on the stage of disease at presentation [6—8], other patient level factors may impact both short- and long-term outcomes.

The impact of body mass index (BMI) on surgical outcomes has been studied in patients undergoing a variety of cancer operations of the colon [9], rectum [10], endometrium [11], pancreas [12], and liver [13,14]. The impact of non-normal BMI on outcomes after gastrectomy for adenocarcinoma, however, is less well defined. Although some investigators have found an association between non-normal BMI and increased perioperative complications [15—18], other investigators have reported minimal or no change in the incidence of perioperative morbidity based on BMI [19]. Furthermore, results on the impact of BMI on recurrence-free and long-term overall survival (OS) are inconsistent [16,20]. The reason for these disparate results is probably multifactorial. Many previous studies were small, single-center studies [16], or did not involve patients from the United States [15,19,20], making it difficult to extrapolate results to a Western population with different morphometric features. In addition, most prior studies were heterogenous with regard to inclusion criteria and definition of BMI categories. For example, some studies looked exclusively at patients with abnormally high BMI and grouped underweight individuals as "normal" [16,21]. Categorizing low BMI patients as "normal" can be problematic, however, as low BMI has been linked to worse outcomes for other cancers [22,23].

Given the epidemic of obesity and the increased incidence of gastric adenocarcinoma among obese patients [24], data on the impact of BMI on gastric cancer surgery outcomes are important. Therefore, the objective of the present study was to define the impact of BMI on perioperative and long-term outcomes among patients undergoing gastric resection for adenocarcinoma using a large multi-institutional cohort of US patients.

2. Materials and methods

2.1. Patient selection

All patients undergoing gastric resection for gastric adeno-carcinoma between 2000 and 2012 at one of the seven participating institutions in the US Gastric Cancer Collaborative (Johns Hopkins Hospital, Baltimore, MD; Emory University, Atlanta, GA; Stanford University, Palo Alto, CA; Washington University, St. Louis, MO; Wake Forest University, Winston-Salem, NC; University of Wisconsin, Madison, WI; The Ohio State University, Columbus, OH) were identified. Patients from the original US Gastric Cancer Collaborative cohort with metastatic stage IV disease ($n = 101$) were excluded from analysis. Standard demographic, clinicopathologic, tumor, and treatment-related variables were collected. Specifically, patient age, sex, presence of comorbidities, and preoperative BMI were collected. Patients were classified according to the World Health Organization BMI classification system as follows: underweight (<18.5 kg/m^2), normal (18.5—24.9 kg/m^2), overweight (25.0—29.9 kg/m^2), and obese (≥30 kg/m^2) [25]. Tumor location, size, number of lesions, histologic type and grade, depth of invasion, number of lymph nodes harvested, number of metastatic lymph nodes, and the American Joint Committee on Cancer (AJCC) stage were also collected and recorded [26]. Treatment-related factors that were collected included type and extent of resection (partial *versus* total gastrectomy), operative time, estimated blood loss (EBL), and need for perioperative blood transfusion. Pathologic data included margin status, which was categorized as microscopically negative (R0) and microscopically (R1) or macroscopically (R2) positive.

The primary outcomes of interest were perioperative 30-d morbidity, as well as long-term OS. The highest grade of complication was recorded based on the Clavien—Dindo classification system [27]. Infectious complications were categorized together and included both superficial and deep surgical site wound infections as well as deep intra-abdominal collections or sepsis. Data on postoperative outcome metrics such as total hospital length of stay (LOS), location of discharge (home *versus* non-home), and incidence of hospital readmission were also collected. Date of last follow-up, vital status, recurrence-free survival (RFS), and recurrence-related information were also collected on all patients.

2.2. Statistical analysis

Discrete variables were described as medians with interquartile range (IQR), and categorical variables were described as totals and frequencies. Univariate comparisons were