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# Impact of body mass index on the short-term outcomes of resected gastrointestinal stromal tumors



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## ABSTRACT

**Background:** Potentially curative treatment for gastrointestinal stromal tumors (GIST) involves resection with selective utilization of tyrosine kinase inhibitors. A potential association between obesity and GIST has been postulated as GIST is among the most common incidental findings during gastric resection for bariatric procedures. The purpose of this study is to investigate the relationship and impact of obesity on the pathologic and short-term outcomes in patients with GIST.

**Methods:** We performed a retrospective review of patients with resected GIST. The impact of obesity, defined as body mass index (BMI)  $\geq 30$  kg/m<sup>2</sup>, on pathologic results and short-term outcomes was evaluated.

**Results:** Sixty-one patients underwent resection with a median follow-up of 26 mo (1–129 mo). Disease involved the stomach (74%), small intestine (18%), or colon/rectum (5%). Median tumor size was 6 cm, and 13 patients (21%) underwent multivisceral resection. Median BMI for the cohort was 27.2 kg/m<sup>2</sup>, and 24 patients (39%) were classified as obese based on BMI. Nonobese patients were noted to have larger primary tumors (median: 7 cm versus 5 cm,  $P = 0.02$ ) and undergo multivisceral resection more frequently (32.4% versus 4.2%,  $P < 0.01$ ). Short-term outcomes were similar between the groups, with a slight trend toward more postoperative complications among the obese patients.

**Conclusions:** In this study, obese patients tended to have more favorable pathologic features. GISTs may represent another example of the “obesity paradox” in which obesity seemingly provides a protective effect. Larger studies are warranted to verify the impact of obesity on outcomes and to elucidate any underlying clinicopathologic/biologic factors.

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## Introduction

Gastrointestinal stromal tumors (GISTs) are the most common soft tissue sarcoma of the gastrointestinal tract. They represent a spectrum of disease with diverse clinical behavior and varying degrees of aggressiveness based on primary tumor location, size, and rate of mitoses.<sup>1</sup> Several recent reports have described incidentally discovered GISTs during bariatric surgical procedures, raising the question of a potential association between obesity and the incidence of these tumors.<sup>2-6</sup> Of note, the tumors described in these series tended to be small with low-risk pathologic features.

Obesity represents a nationwide epidemic with recent large scale studies suggesting that nearly one-third of the US population qualify as obese (body mass index [BMI]  $\geq 30$  kg/m<sup>2</sup>).<sup>7</sup> This is particularly alarming when considering that obesity is associated with significantly higher all-cause mortality when compared to normal weight individuals. Although epidemiologic factors such as race and gender have been previously examined for patients with GIST,<sup>8</sup> the impact of obesity in this population has not been assessed. Furthermore, to our knowledge, no study has examined outcomes with regard to obesity among patients with GIST or compared this group to their nonobese counterparts.

The aim of the present study was to examine the impact of obesity on pathologic and short-term outcomes for patients with resected GIST. Based on what seem to be favorable outcomes of obese patients incidentally undergoing resection of GIST, we hypothesize that obese patients display more favorable tumor pathology and subsequently may experience improved early outcomes compared to those patients not classified as obese undergoing similar resections.

## Patients and methods

### Patients

After institutional review board approval, the University of Tennessee Health Science Center and Methodist University Hospital tumor registries were queried, and a retrospective review was conducted of patients with a diagnosis of GIST who underwent surgical consultation from September 2005 through January 2016. Altogether, 81 patients were identified. After review of pathologic data, five patients were excluded: three patients because final pathology was not consistent with GIST and two patients who had undergone surgical resection in another state and complete records were not available for analysis. A total of 76 patients were referred to surgery during the specified time period, of which 61 ultimately underwent surgical resection and were further analyzed.

### Body mass index

BMI is a simple index of weight-to-height universally utilized to classify individuals into categories of body weight such as underweight (BMI  $< 18.5$  kg/m<sup>2</sup>), normal weight (BMI: 18.5-24.99 kg/m<sup>2</sup>), overweight (BMI: 25-29.99 kg/m<sup>2</sup>), and obese (BMI  $\geq 30$  kg/m<sup>2</sup>). Those classified as obese can be further

subdivided into obese class I (BMI: 30-34.99 kg/m<sup>2</sup>), obese class II (BMI: 35-39.99 kg/m<sup>2</sup>), and obese class III (BMI  $\geq 40$  kg/m<sup>2</sup>).<sup>9,10</sup> For the present study, BMI was determined as the value on admission for surgical resection as this was consistently available. BMI  $\geq 30$  kg/m<sup>2</sup> was used as the standard definition of obesity.

### Data collection

Patient demographics, clinicopathologic, operative, and perioperative data, along with outcomes were compiled. The site of primary disease along with type and duration of preoperative therapy (if any) was noted for each patient. Tumor size was assessed based on results from pathologic evaluation of the resected GIST. Multivisceral resection was defined as resection of one or more further organs in addition to the primary tumor. A mitotic rate greater than 5/50 high powered fields (HPFs) was considered high grade, based on American Joint Committee on Cancer (AJCC) staging criteria.<sup>11</sup> Due to the variability of reporting of mitotic rate for the past several years, values were converted from mm<sup>2</sup> to HPF as appropriate based on conversion factors described previously for other tumors.<sup>12,13</sup> The presence of multifocal disease, sarcomatosis, or tumor necrosis were documented. C-Kit mutational status was noted for all patients along with exon mutational analysis when performed. Complications were graded according to the classification schema established by Dindo et al.<sup>14</sup> Additional short-term data were determined including the rates of rehab transfer, readmission, and 30-day mortality.

After analysis of the entire study population, patients were divided and analyzed according to BMI to evaluate potential differences in pathologic outcomes as well as short-term perioperative sequelae. Focus was paid to pathologic outcomes that were known to be associated with prognosis including tumor site, size, and rate of mitoses.

### Statistical analysis

Continuous variables were summarized using median with interquartile range (IQR), and categorical variables were summarized using proportions. Characteristics were compared using a two-sample *t*-test for continuous variables and Fisher's exact test for categorical variables. One-way analysis of variance was utilized to compare the means of more than two groups. BMI was directly compared to tumor size as a continuous variable. Multivariate linear regression analysis was performed to determine potential independent predictors of pathologic tumor size. All *P* values were based on a two-tailed statistical analysis with a *P* value  $< 0.05$  considered indicative of statistical significance. Statistical analysis was conducted using SPSS software, version 24 (IBM SPSS Statistics).

## Results

### Patient characteristics

A total of 61 patients were analyzed over a 10-year period. The majority of patients were female (59.0%) and

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