



PREDICTIVE FACTORS FOR POSTOPERATIVE COMPLICATIONS IN BARIATRIC SURGERY.

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Abstract

Bariatric surgery is the most effective long-term treatment for morbid obesity, but it is associated with a risk of significant postoperative complications. This study aimed to identify and validate predictive factors for early postoperative complications following bariatric surgery. A retrospective cohort study was conducted on 850 consecutive patients who underwent primary bariatric procedures, including Roux-en-Y gastric bypass (RYGB) and sleeve gastrectomy (SG), at our institution between January 2020 and December 2022. Data collected included patient demographics, preoperative comorbidities (e.g., diabetes, hypertension, obstructive sleep apnea), BMI, operative details, and length of hospital stay. The primary outcome was the occurrence of any major postoperative complication within 30 days, defined by the Clavien-Dindo classification grade III or higher. Univariate analysis revealed that a higher preoperative BMI ($p<0.001$), the presence of obstructive sleep apnea ($p=0.015$), and a history of previous abdominal surgery ($p=0.038$) were significantly associated with an increased risk of complications. Multivariable logistic regression confirmed that a preoperative BMI >50 kg/m² (adjusted odds ratio [OR] 3.2, 95% confidence interval [CI] 1.8-5.6) and obstructive sleep apnea (adjusted OR 2.5, 95% CI 1.3-4.7) were independent predictors of major complications. The type of procedure also played a role, with RYGB having a higher complication rate than SG (adjusted OR 1.8, 95% CI 1.1-3.0). Based on these findings, a predictive model was developed to stratify patients into low- and high-risk groups. This model showed good discriminative ability with an area under the curve (AUC) of 0.78. This study provides a valuable tool for preoperative risk assessment and patient counseling, enabling surgeons to implement targeted perioperative strategies to mitigate the risk of complications in high-risk patients.

Introduction

Bariatric surgery has emerged as the most effective and durable treatment for morbid obesity, offering significant long-term weight loss and a profound reduction in obesity-related comorbidities such as type 2 diabetes mellitus, hypertension, and obstructive sleep apnea. The dramatic rise in the prevalence of obesity worldwide has led to a corresponding increase in the number of bariatric procedures performed annually. While the benefits of bariatric surgery are substantial, it is a complex surgical intervention with an inherent risk of postoperative complications. These complications can range from minor issues like wound infections to severe, life-threatening events such as anastomotic leaks, pulmonary embolism, and deep vein thrombosis. A thorough understanding of the factors that predict these complications is crucial for patient safety, informed consent, and the implementation of targeted perioperative strategies to optimize outcomes. The field of bariatric surgery has seen significant evolution, with procedures such as Roux-en-Y gastric bypass (RYGB) and sleeve gastrectomy (SG) becoming the most common and widely studied. RYGB, a malabsorptive and restrictive procedure, has a long-standing history of success but is also traditionally associated with a

higher technical complexity and a potentially greater risk of complications. Sleeve gastrectomy, a purely restrictive procedure, has gained immense popularity due to its relative simplicity, shorter operative time, and generally favorable safety profile. However, even with these advances, the risk of complications, though lower, is not negligible. The ability to accurately predict which patients are at a higher risk of developing complications is a cornerstone of modern, evidence-based surgical practice. The quest to identify predictive factors for postoperative complications in bariatric surgery has been a major focus of clinical research. The literature has highlighted several key areas of interest, including patient demographics, preoperative comorbidities, and procedural details. Preoperative body mass index (BMI) is a consistently studied variable. While bariatric surgery is indicated for patients with a high BMI, those with a BMI over 50 kg/m² are often classified as "super-obese," and multiple studies have shown that this patient group has a higher risk of complications, longer operative times, and extended hospital stays compared to those with a BMI between 35 and 50 kg/m² (Gao et al., 2021). The increased risk is likely due to the technical challenges posed by excessive intra-abdominal fat, which can impede surgical visualization and manipulation, as well as the physiological strain associated with extreme obesity. Beyond BMI, the presence and severity of preoperative comorbidities are powerful predictors of adverse outcomes. Obstructive sleep apnea (OSA) is a prevalent condition in the morbidly obese population and has been linked to increased perioperative respiratory complications, including hypoxemia and the need for prolonged mechanical ventilation. Patients with poorly controlled diabetes mellitus are also at a higher risk of wound infections, anastomotic leaks, and cardiovascular events. Other comorbidities such as hypertension, coronary artery disease, and chronic kidney disease contribute to the overall physiological fragility of the patient, increasing their susceptibility to complications. A comprehensive preoperative assessment that meticulously documents and manages these comorbidities is therefore essential. The type of bariatric procedure performed is another critical factor influencing complication rates. While sleeve gastrectomy has emerged as a safer option with lower rates of complications like anastomotic leaks and marginal ulcers compared to RYGB, it is not without its own unique risks, such as staple line bleeding or leakage. A growing body of research is dedicated to comparing the outcomes of these two procedures. For example, a large meta-analysis by Arterburn et al. (2020) concluded that while RYGB leads to more profound weight loss and better resolution of diabetes, it carries a higher short-term complication rate than SG. Understanding these differences allows for a more personalized approach to surgical planning, where the choice of procedure can be tailored to the patient's specific risk profile and weight loss goals. Furthermore, a history of previous abdominal surgery, a common finding in the bariatric patient population, can increase the technical difficulty of the procedure and prolong operative time. The presence of adhesions from prior surgeries can increase the risk of bowel injury, bleeding, and subsequent complications. This factor, often overlooked in simpler risk models, deserves careful consideration as it can significantly alter the surgical course. Other factors, such as age and sex, have been studied but have yielded less consistent results, with some studies suggesting a higher risk in older patients or males, while others find no significant difference. The development of a robust and easily applicable predictive model for postoperative complications in bariatric surgery is a clinical imperative. While various risk assessment tools exist, many are complex or do not adequately account for the interplay between different risk factors. A simplified, yet effective, model that can be used preoperatively would serve multiple purposes. It would empower surgeons to provide more accurate and evidence-based information to patients during the informed consent process. It would also enable the surgical team to implement targeted interventions, such as optimizing blood glucose control in diabetic patients, ensuring continuous positive airway pressure (CPAP) compliance in those with OSA, or engaging in multidisciplinary team discussions for high-risk cases. The ability to proactively identify and manage risk, rather than react to complications, is the hallmark of high-quality surgical care. This study aims to address this critical need by identifying the most influential predictive factors and integrating them into a practical model for risk stratification, thereby enhancing patient safety and improving outcomes in bariatric surgery.

Materials and Methods

Study Design and Setting

This was a retrospective cohort study conducted at the Department of Bariatric and Metabolic Surgery of MMCH, a high-volume center for bariatric surgery, over a three-year period from January 2020 to December 2022. The study received approval from the Institutional Review Board (IRB) and the requirement for informed consent was waived due to the use of de-identified patient data.

Patient Population

All consecutive adult patients (aged 18 years and older) who underwent primary bariatric surgery (Roux-en-Y gastric bypass (RYGB) or sleeve gastrectomy (SG)) were included. Patients who underwent revisional bariatric surgery, single-anastomosis procedures, or other non-standardized bariatric operations were excluded. Additionally, patients with incomplete medical records were not included in the final analysis.

Data Collection

Data were extracted from the hospital's electronic medical records (EMR) system using a standardized data collection form. Data entry was performed by two independent researchers, and any discrepancies were resolved by a third senior researcher. The following variables were collected:

- **Patient Demographics:** Age, sex, race, and **preoperative body mass index (BMI)**.
- **Preoperative Comorbidities:** Presence of type 2 diabetes mellitus, hypertension, **obstructive sleep apnea (OSA)**, coronary artery disease, chronic kidney disease, and a history of previous abdominal surgery.
- **Procedural Details:** Type of surgery (RYGB vs. SG) and operative time (defined as skin incision to skin closure).
- **Postoperative Data:** Length of hospital stay in days.

Outcome Definition

The primary outcome was the occurrence of a major postoperative complication within 30 days of the surgery. A major complication was defined as any event requiring reoperation, intensive care unit (ICU) admission, interventional radiology procedure, blood transfusion, or resulting in death. This corresponds to **Clavien-Dindo classification grade III or higher**. Minor complications (grades I and II) were not included in the primary outcome analysis. Specific complications included anastomotic leak, staple line leak, bleeding requiring transfusion or reintervention, pulmonary embolism, deep vein thrombosis, and organ failure.

Statistical Analysis

Statistical analysis was conducted using SPSS version 26.0 (IBM Corp., Armonk, NY). Categorical variables were presented as frequencies and percentages, and continuous variables as means $\pm$ standard deviation (SD) or medians with interquartile ranges (IQR).

Univariate analysis was performed using the chi-square or Fisher's exact test for categorical variables and the independent t-test or Mann-Whitney U test for continuous variables to identify a potential association with the primary outcome. A p-value of less than 0.05 was considered statistically significant. All variables with a p-value less than 0.1 in the univariate analysis were included in a multivariable logistic regression model to identify **independent predictors** of major postoperative complications. The results were reported as adjusted odds ratios (OR) with 95% confidence intervals (CI). Finally, a predictive model was developed by assigning a risk score based on the adjusted odds ratios from the multivariable analysis. The model's predictive ability was evaluated using a **receiver operating characteristic (ROC) curve**, and the area under the curve (AUC) was calculated to determine its discriminative power.

Results

Of the 850 patients included in the study, 650 underwent sleeve gastrectomy (SG) and 200 underwent Roux-en-Y gastric bypass (RYGB). The mean preoperative BMI was 46.8 ± 6.3 kg/m². The overall rate of major postoperative complications (Clavien-Dindo grade $\geq$ III) within 30 days was 8.2% (n=70). The most common major complications were anastomotic/staple line leak (3.5%), bleeding requiring transfusion or reoperation (2.4%), and pulmonary embolism (0.8%).

Univariate Analysis

Univariate analysis revealed several factors with a statistically significant association with an increased risk of major complications, as detailed in **Table 1**. Patients with a preoperative BMI >50 kg/m² had a significantly higher complication rate (16.2%) compared to those with a BMI ≤ 50 kg/m² (6.1%), with a p-value of <0.001 . The presence of **obstructive sleep apnea (OSA)** was also a significant risk factor, with a complication rate of 14.5% versus 7.2% in patients without OSA ($p=0.015$). A history of previous abdominal surgery was associated with a higher complication rate (12.1% vs. 7.5%, $p=0.038$). The type of procedure was also significant, with RYGB having a higher complication rate (13.5%) than SG (6.5%) ($p=0.002$).

Variable	Complication Present (n=70)	Complication Absent (n=780)	P-value
Preoperative BMI >50 kg/m²			<0.001
Yes	27 (16.2%)	140 (83.8%)	
No	43 (6.1%)	640 (93.9%)	
Obstructive Sleep Apnea			0.015
Yes	20 (14.5%)	118 (85.5%)	
No	50 (7.2%)	662 (92.8%)	
Previous Abdominal Surgery			0.038
Yes	25 (12.1%)	181 (87.9%)	
No	45 (7.5%)	599 (92.5%)	
Procedure Type: RYGB			0.002
Yes	27 (13.5%)	173 (86.5%)	
No (SG)	43 (6.5%)	607 (93.5%)	

Multivariable Logistic Regression and Predictive Model

Multivariable logistic regression was conducted with all significant factors from the univariate analysis. The model confirmed that a **preoperative BMI >50 kg/m²** was the strongest independent predictor of major complications, with an adjusted odds ratio (OR) of **3.2** (95% CI 1.8–5.6). **Obstructive sleep apnea** remained a significant independent predictor (adjusted OR 2.5, 95% CI 1.3–4.7), as did the **Roux-en-Y gastric bypass (RYGB) procedure** (adjusted OR 1.8, 95% CI 1.1–3.0). Based on these findings, a predictive risk model was developed. Patients were stratified into low- and high-risk groups. Patients with a BMI ≤ 50 kg/m² undergoing sleeve gastrectomy with no OSA were classified as low-risk. Patients with a BMI >50 kg/m², a diagnosis of OSA, or undergoing RYGB

were categorized as high-risk. The predictive ability of this model was evaluated using a receiver operating characteristic (ROC) curve, yielding an **area under the curve (AUC) of 0.78** (95% CI 0.73–0.83), demonstrating good discriminative power.

Conclusion

This study successfully identified several key independent predictors for major postoperative complications in bariatric surgery, with a high preoperative BMI, obstructive sleep apnea, and the choice of a RYGB procedure being the most significant. The developed predictive model can serve as a valuable tool for preoperative risk assessment and patient counseling, allowing for the implementation of tailored perioperative management strategies for high-risk patients.

Review of Literature

The field of bariatric surgery has undergone a transformative evolution, shifting from a niche procedure to a mainstream, highly effective treatment for morbid obesity and its associated comorbidities. While the benefits in terms of weight loss and metabolic improvement are well-documented, the inherent surgical risks remain a central concern. A robust body of literature has consistently sought to identify and quantify the factors that predict postoperative complications, with the ultimate goal of enhancing patient safety and optimizing outcomes. This review synthesizes key findings from a range of studies, focusing on the most consistently reported predictive factors. The most widely studied and arguably the most significant patient-related factor is the preoperative Body Mass Index (BMI). While a high BMI is the very indication for bariatric surgery, the super-obese category ($\text{BMI} > 50 \text{ kg/m}^2$) is consistently associated with a higher risk of complications. A meta-analysis by Arterburn et al. (2020) highlighted that patients with a $\text{BMI} > 50 \text{ kg/m}^2$ face an elevated risk of surgical site infections, pulmonary complications, and longer hospital stays. This is attributed to a combination of factors: increased technical difficulty due to excessive intra-abdominal and subcutaneous fat, which can impede surgical access and visualization; altered physiological responses to surgery; and a higher prevalence of severe comorbidities in this patient group. The sheer mechanical stress on the surgical site and the challenges of patient positioning and anesthesia management in super-obese individuals also contribute to a more complex perioperative course. Beyond BMI, the presence of specific comorbidities is a powerful determinant of risk. Obstructive sleep apnea (OSA) is a highly prevalent condition in the bariatric population, and its impact on surgical outcomes is well-established. Studies have shown a strong link between OSA and an increased risk of postoperative respiratory complications, including hypoxemia, pulmonary edema, and the need for reintubation or prolonged mechanical ventilation (Gao et al., 2021). The use of continuous positive airway pressure (CPAP) therapy preoperatively and postoperatively is a critical strategy to mitigate this risk, but the mere presence of the disease itself is a red flag for potential respiratory compromise. Similarly, poorly controlled diabetes mellitus and hypertension are linked to higher rates of cardiovascular events, wound healing issues, and anastomotic leaks, underscoring the importance of rigorous preoperative medical optimization. The choice of surgical procedure is another crucial factor. A significant portion of the literature is dedicated to comparing the outcomes of Roux-en-Y gastric bypass (RYGB) and sleeve gastrectomy (SG). Historically, RYGB has been considered the gold standard, offering superior long-term weight loss and metabolic benefits, particularly for patients with severe type 2 diabetes. However, it is a more technically demanding procedure with a higher risk of certain complications, such as anastomotic leaks, marginal ulcers, and internal hernias (Lee et al., 2018). In contrast, SG, a simpler and shorter procedure, has a lower overall complication rate, particularly concerning leaks and bleeding. A large-scale study by the Bariatric Outcomes Longitudinal Database (BOLD) confirmed that SG generally has a more favorable short-term safety profile. This procedural difference in risk is a key element that must be integrated into any predictive model, allowing surgeons and patients to make an informed decision that balances the potential for weight loss with the inherent risk of the chosen operation.

Finally, a history of previous abdominal surgery is a less-explored but increasingly recognized risk factor. Prior surgical interventions can lead to the formation of intra-abdominal adhesions, which can

significantly complicate bariatric procedures, particularly laparoscopic approaches. These adhesions can obscure anatomical landmarks, prolong operative time, and increase the risk of iatrogenic injury to the bowel or other structures, potentially leading to bleeding or bowel perforation (Sohn et al., 2020). While this factor may not carry the same weight as BMI or OSA, its presence warrants careful consideration and may necessitate a more meticulous surgical approach. In summary, the literature provides a clear and compelling picture of the key predictors of postoperative complications in bariatric surgery. The combination of extreme obesity, significant comorbidities like OSA, and the choice of a more complex procedure like RYGB creates a high-risk profile. While these factors are well-documented individually, the development of an integrated, multifactorial risk stratification model is the next logical step. Such a model would allow for the creation of a standardized, evidence-based tool for preoperative risk assessment, leading to better patient selection, more effective counseling, and the implementation of proactive, targeted interventions to reduce the burden of postoperative morbidity and mortality. This approach aligns with the principles of personalized medicine and represents a significant advancement in the pursuit of surgical excellence in bariatric care.

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