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The High-Risk Bariatric Patient

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Over the past decade, the number of patients undergoing weight loss surgery has increased exponentially with approximately 13,000 patients undergoing weight loss surgery in 1998 to 200,000 patients in 2009 [1]. During that time, advances in technique and approach to bariatric surgery have decreased the morbidity of these procedures, thus allowing patients that were previously at unacceptably high risk to now be candidates for weight loss surgery. Oftentimes the very comorbidities that placed these patients at high risk (namely, cardiopulmonary disease) are the same comorbidities that effective long-term weight loss could improve.

Careful identification and perioperative management of these higher-risk patients is crucial in decreasing morbidity after weight loss surgery. Recognizing that these patients needed to be specifically identified, the American Heart Association issued "A Science Advisory" in 2009 concerning the evaluation and management of severely obese patients undergoing surgery [1]. Obesity is associated with many comorbidities either known or unknown. Overall risk of developing anyone of a number of comorbidities rises with an increasing BMI. It has been noted that the number of individuals with a BMI > 50 kg/m^2 has quintupled between 1986 and 2000. For this reason, the scientific advisory was developed to provide recommendations concerning preoperative cardiopulmonary evaluation of severely obese patients undergoing surgery [1]. These recommendations included risk factors such as age, BMI, gender, hypertension, and history of venous thromboembolic events. These risk factors were drawn from the Obesity Surgery Mortality Risk Scoring system developed by DeMaria in 2007 and validated by several other studies since that time [2–4].

However, in addition to these risk factors, there are other factors that place certain patients at higher risk when undergoing weight loss surgery. When considering weight loss surgery on these patients, careful preoperative preparation and perioperative multidisciplinary management can lead to successful outcomes and durable comorbidity resolution or reduction.

This chapter evaluates the evidence behind each of these risk factors and suggests strategies for perioperative planning and risk reduction to aid in the identification and surgical care of the high-risk bariatric patient.

Estimating Risk

Who is the high-risk patient? Every patient undergoing a procedure requiring anesthesia is given an American Society of Anesthesiologist's (ASA) classification category. This category system was developed in 1941 and revised in 1963. Since that time, the ASA classification has been extensively evaluated and correlates well as a predictor of postoperative morbidity and mortality [5]. However, the majority of patients undergoing weight loss surgery have an ASA classification of three or higher based on the BOLD database, making them all high risk by conventional standards [3]. This created a need to further define risk categories within the bariatric population that would guide the perioperative work-up and management.

In 2007 DeMaria and colleagues evaluated 2,075 patients undergoing gastric bypass surgery seeking to define which variables could be used to predict postoperative mortality [2]. They found that BMI, male gender, hypertension, history of venous thromboembolic event, and age greater than 45 were significant independent predictors of mortality. They further developed the Obesity Surgery Mortality Risk Score (OS-MRS). This scoring system is divided into three classes A, B, and C, where each of the five variables is assigned one point. Patients with 0–1 point are included in category A, 2–3 points category B, and 4–5 points category C. Categories A, B, and C were associated with a 0.3 %, 1.90 %, and 7.56 % mortality risk, respectively (Table 1).

That same year, Buchwald and colleagues conducted a meta-analysis to evaluate a 30-day mortality based on type (gastric banding, gastroplasty, gastric bypass, or BPD/DS, or revisional surgery) and approach (laparoscopic vs open) of weight loss surgery [4]. They found significant differences in

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Table 1. Obesity surgery mortality risk score

Class	No. of points	Mortality rate (%)
A	0–1	0.31
B	2–3	1.90
C	4–5	7.56

One point assigned for each of the following: BMI > 50 kg/m^2, male gender, HTN, PE risk, Age >45 years

Table 2. Thirty-day mortality for bariatric surgery by procedure

Surgery type	Death ≤30 days, mean (95 % CI)
Gastric banding	
Open	0.18 (0.00–0.49)
Laparoscopic	0.06 (0.01–0.11)
Gastroplasty	
Open	0.33 (0.15–0.51)
Laparoscopic	021 (0.00–0.48)
Gastric bypass	
Open	0.44 (0.25–0.64)
Laparoscopic	0.16 (0.09–0.23)
Biliopancreatic diversion/duodenal switch	
Open	0.76 (0.29–1.23)
Laparoscopic	1.11 (0.00–2.70)
Revisional surgery	
Open	0.96 (0.09–1.82)
Laparoscopic	0.00 (0.00–1.47)

Adapted from Buchwald et al.

mortality between the various types and approaches to weight loss surgery (Table 2).

Given the evolving definition of the high-risk patient within the bariatric population, the American Heart Association sought to clarify at least the clinical work-up for such patients, thus giving further definition to the high-risk bariatric patient. The 2009 Science advisory from the American Heart Association delineated numerous obesity-related comorbidities that influence the preoperative cardiac assessment and ultimately the management of the severely obese patient. These risk factors included atherosclerotic cardiovascular disease, heart failure, systemic hypertension, pulmonary hypertension related to sleep apnea and obesity hypoventilation, cardiac arrhythmias, deep vein thrombosis, history of pulmonary embolism, and poor exercise capacity [1]. In addition to these factors, the AHA included data from the Women's Health Initiative Observational Study suggesting that diabetes mellitus, elevated serum triglyceride levels, reduced serum high-density lipoprotein cholesterol levels, chronic inflammation, and prothrombotic state associated with obesity contribute to these patients' overall cardiovascular risk. This science advisory also incorporated the Buchwald data in the discussion of assessing preoperative risk.

Additional studies have sought to evaluate other independent risk factors for morbidity and mortality after weight loss surgery. One of the more surprising significant risk factors for increased morbidity and mortality was published in Archives of Surgery in 2006 by Livingston [6]. He evaluated 25,428 patients having undergone bariatric surgery and found several factors that increased mortality with bariatric surgery: increasing age, male gender, electrolyte abnormalities, and congestive heart failure. He also found that the patients that had Medicare had greater disease burden and thus had higher morbidity.

Finally in 2011, Nguyen proposed a revised bariatric mortality risk classification system for patients undergoing bariatric surgery [7]. This updated, but more complicated, classification system encompassed those factors in DeMaria's classification system and added other risk factors such as presence of diabetes, Medicare status, and type of operation and approach. The significance of this system is the acknowledgement of the differences in the risk profiles of the different types and approaches (open vs laparoscopic) to weight loss surgery.

By using these classification systems and the considerations presented by the American Heart Association, patients that have multiple risk factors can be identified early in the preparation period. They can then be medically optimized for a risk-appropriate weight loss surgery. These patients can more appropriately be counseled as to their increased risk for complications after surgery. However, using a multidisciplinary approach, the perioperative management can help effectively decrease overall morbidity and mortality.

Risk Factors

Age

It has been well demonstrated that advanced age increases postoperative morbidity and mortality for any surgery. Specifically in a study by Livingston in 2006 published in the Archives of Surgery, advanced age (≥65 years) was seen as an independent risk factor for adverse outcomes as defined as length of hospital stay >95th percentile, being discharged to a long-term care facility or having died during the hospital admission for weight loss surgery [6]. Interestingly, they found that there was steady increase in rate of adverse events as age increased. However, there was a sharp increase in rate of adverse events at age 60. Beyond the age of 65, there was a 32 % rate of adverse events and a 3.2 % mortality rate.

Nguyen et al. evaluated more than 105,000 patients between 2002 and 2009. They found that age greater than 60 was a significant factor for in-hospital mortality from the multiple logistic regression analysis [7].

Gender

There are several well-performed studies that demonstrate that male gender is an independent risk factor for perioperative complications after weight loss surgery. In fact when DeMaria was developing the Obesity Surgery Mortality Risk

Score, his evaluation of the >2,000 gastric bypass patients demonstrated that male gender was an independent risk factor for mortality [2]. Livingston came to similar conclusions in his study in 2006 [6]. However, more recently (2011), Nguyen et al. suggested that even more than advanced age, male gender was associated with greater mortality after bariatric surgery [7]. Because of this, he gave male gender a greater contribution to his bariatric mortality risk classification.

Body Mass Index

Elevated weight or body mass index has been evaluated in many studies [8–10]. It seems intuitive that there would be a direct relationship between increasing BMI and risk of perioperative morbidity. Frequently as BMI increases, the physiology of the patient deteriorates. Patients with elevated BMIs typically have a higher incidence of cardiopulmonary insufficiency including right heart failure, pulmonary hypertension, obstructive sleep apnea, and obesity-related hypoventilation syndrome [8–10]. In addition to the physiologic consequences of morbid obesity, there are also mechanical challenges that these patients present. Their thickened abdominal wall, large liver, increased intraperitoneal fat, and limited working space after insufflation add to the technical difficulty of the procedure and may lengthen the duration of surgery [11, 12]. Acute presurgical weight loss may help ameliorate some of these technical difficulties and possibly decrease overall complications [13, 14]. All of these factors probably contribute to the fact that elevated BMI has been found in multiple studies, such as DeMaria's evaluation of 2,075 gastric bypass patients, to be an independent risk factor for perioperative mortality especially in BMI >50 [2].

Thromboembolic Disease

Darvall et al. did an extensive review of the relationship between obesity and venous thrombosis [15]. Within this review which included a medline review and Cochrane data base search from 1966 to 2005, a number of mechanisms were identified which connected obesity and venous thrombotic events.

In fact, the adipose tissue itself acts as an endocrine, paracrine, and autocrine organ, regulating among other processes, vascular homeostasis. The substances that are secreted by the adipose tissue that are potentially involved with venous thrombosis include leptin, adiponectin, resistin, plasminogen activator inhibitor-1 (PAI-1), tissue factor, angiotensin II, and other substances of the renin-angiotensin system, non-esterified free fatty acids (NEFAs), tumor necrosis factor-a (TNF-a), transforming growth factor-b (TGF-b), and interleukin-6 (IL-6) [15].

Leptin has been found to potentiate the aggregation of platelets by enhancing ADP's and thrombin's pro-aggretory effect on platelets. It also increases the synthesis of C-reactive protein contributing to the chronic inflammatory state of obesity. Tissue factor, also secreted from adipose tissue, initiates the coagulation cascade when exposed to blood and bound to factor VIIa. Obese individuals demonstrate higher levels of TF-mediated coagulation. Finally IL-6, a proinflammatory cytokine, secreted from adipose tissue has direct effect on inflammation in the human body. IL-6 overproduction has been implicated in the pathogenesis for inflammatory conditions such as rheumatoid arthritis, Crohn's disease, and juvenile idiopathic arthritis. Approximately one third of circulating IL-6 is produced from adipose tissue, and patients that are morbidly obese have higher circulating levels of IL-6. IL-6 inhibits gene expression and secretion of adiponectin, a powerful anti-inflammatory mediator. This may contribute to increased platelet aggregation and endothelial adhesion.

Furthermore, obese individuals have chronically elevated intra-abdominal pressure and decreased blood velocity in the common femoral vein resulting in venous stasis and ultimately contributing to increased risk for deep venous thrombus formation.

DeMaria recognized the elevated risk of these patients and included "PE risk" in his mortality risk score [2]. He found that the combination or presence of any of the following findings—previous VTE event, previous IVC filter placement, a history of right heart failure or pulmonary hypertension, history of physical findings of venous stasis including brawny edema or typical ulcerations—was highly statistically significant as a predictor of postoperative mortality. As such, he included "PE risk" in his mortality risk score system, underscoring the fact that pulmonary embolism is the leading cause of mortality in bariatric surgery centers, where the incidence of pulmonary embolism in patients who have undergone surgical procedures has been reported as high as 2 % [16].

Risk reduction strategies for decreasing thromboembolic events in patients that are at high risk include preoperative placement of vena cava filters, heparin windows, preoperative subcutaneous heparin administration, postoperative home administration of Lovenox, etc. In an analysis of the BOLD data base by Li, it was found that surgeons more typically put vena cava filters in patients with higher BMIs, that are African-American, who have had previous surgeries, who have prior history of venous thromboembolism, impaired functional status, lower extremity edema, obstructive sleep apnea, and pulmonary hypertension [17]. Interestingly, the patients that had the vena cava filters placed also had a higher incidence of DVTs and higher mortality rate. It is presumed that selection bias is responsible for the association between the filters and higher DVT/mortality rate. However, any decision to place a filter should consider the technical difficulty in placement and retrieval in the super-obese.

At our institution, Lovenox is typically given the day of surgery and a prophylaxis dose is given based on BMI.

(BMI > 60 = 60 mg Lovenox BID; BMI <60 = Lovenox 40 mg BID). Also patients with a BMI >55 are given a prescription for home Lovenox for 2 weeks after hospital discharge for extended prophylaxis. Patients with previous DVT/PE, known hypercoagulable state, or other risk factors (immobility) are also given 2–4 weeks of extended prophylaxis after hospital discharge. However, the optimal strategy for prevention of venous thromboembolism in the setting of bariatric surgery is uncertain [18].

Obstructive Sleep Apnea

Obstructive sleep apnea is discussed in detail in Chap. 51. However, in relationship to risk assessment in the high-risk patient, many studies have demonstrated the association with obstructive sleep apnea and perioperative complications. Memtsoudis et al. performed a case control study that evaluated 58,358 orthopedic patients and 45,547 general surgery patients in the journal Anesthesia and Analgesia in 2011. They found that patients undergoing orthopedic and general surgeries were at statistically significant higher risk for aspiration pneumonia, reintubation, ARDS, and mechanical ventilation [19]. That same year in the journal CHEST, Kaw et al. performed a cohort study evaluating 471 patients undergoing noncardiac surgery within 3 years of polysomnography and found that these patients had higher risks of hypoxemia, transfer to the ICU, and an increased length of hospital stay [20].

Vasu et al. included these two studies as well as nine others in their review of the association between obstructive sleep apnea syndrome and perioperative complications in the Journal of Clinical Sleep Medicine in 2012. They pointed out that beyond the risk association between OSA and perioperative complications, many people that have OSA are undiagnosed at the time of surgery. This makes them at higher risk for these complications since they are not being treated for their OSA in the perioperative period [21].

Cardiovascular Disease

In Livingston's population-based study of patients undergoing bariatric surgery, he found the event rate for cardiac complications to be as high as 15.3 per 1,000 patients. And the Women's Health Initiative Observational Study [22] found that the prevalence of myocardial infarction, angina pectoris, percutaneous coronary intervention, and coronary artery bypass graft to be as high as 11.5 % in morbidly obese women (BMI > 40). Thus, it is easy to understand that patients with higher BMIs are at a higher risk for perioperative events.

However, with minimally invasive techniques and shorter operative times, skilled bariatric surgeons are able to safely perform weight loss surgery on patients that have very poor cardiac performance. In fact there are many case reports of patients undergoing weight loss surgery in order to meet criteria for heart transplantation [23, 24]. Oftentimes these patients have left ventricular ejection fractions as low as 15 %. Ramani et al. demonstrated safety and efficacy of bariatric surgery in morbidly obese patients with severe systolic heart failure, improving their New York Heart Association score and left ventricular ejection fraction some of whom then became candidates for transplantation after lowering their BMI while others improved to the point of not requiring transplantation [25]. These types of patients are all cared for by a multidisciplinary team including experienced bariatric surgeons, cardiologists with fellowship training in heart failure, and cardiac anesthesia teams. The conduct in the OR is to minimize operative time while ensuring integrity of the anastomoses. Oftentimes these heart failure patients or heart transplant patients have either internal cardiac defibrillators or pacemakers. Prior to surgery, it is important to identify the type and model of the patient's device, who controls it, what the patient's underlying rhythm is, what the "magnet mode" default is, and if the institution has a programmer on site. Knowing these details will prevent any delay of care if patients should have device malfunctions.

Surgical Factors

Prior Upper Abdominal Surgery

Prior upper abdominal surgery can cause adhesions that can make exposure difficult. Often the stomach and the liver can be fused via adhesions making formation of the pouch very difficult. If the patient has had a midline laparotomy or even lower abdominal surgery, adhesional disease may require tedious and often lengthy lysis of adhesions before enough small bowel is released to measure and create the jejunojejunostomy. When performing weight loss surgery in a patient that has had multiple prior abdominal surgeries, obtaining previous operative notes can help prepare the surgeon for the environment that he is about to discover. Furthermore, having the requisite skill set to laparoscopically repair any surgical misadventures that may be encountered will spare the patient of the short and long-term complications of having to convert to an open procedure.

Occasionally weight loss surgery is required in patients that have received transplanted organs. Obesity with its associated comorbid conditions may lead to early graft failure and poor outcome including death after transplantation [26]. There are several studies that demonstrate that bariatric surgery can be a safe and effective means of weight loss after organ transplantation [27, 28]. In this patient population, active comanagement with the transplant team is essential for good patient outcomes. Immunosuppressive medication levels need to be followed closely in the perioperative period. And to ensure consistent immunosuppressive medication dosing despite variable oral intake, a gastrostomy tube should strongly be considered at the time of the bariatric surgery.

Revisional Surgery

Revisional bariatric surgery is discussed in depth in previous chapters. However, in analyzing revisional surgery with regard to risk, Sarr et al. from Mayo Clinic performed the largest analysis of revisional bariatric surgery outcomes [29]. They evaluated 218 patients that underwent revisional bariatric surgery (open revisions) and they reported a 0.9 % mortality rate and a 26 % serious operative morbidity rate. As expected, this is much higher than the traditionally quoted rates for primary (non-revisional) bariatric surgery [3]. These rates are consistent with other similar studies [30]. In the series presented by Mayo Clinic, it is important to note that all the revisional surgery was performed by experienced bariatric surgeons. Because of the distorted anatomy and extensive scarring that is present in revisional surgery, the risk factor is indirectly related to surgeons' experience performing such complicated surgeries.

Psychiatric Disorders

One of the contraindications for bariatric surgery is uncontrolled psychiatric disorders that would preclude the patient from having coping skills necessary or support structures in place to handle the psychologic stressors of bariatric surgery (ASMBS position statement on presurgical psychologic testing 2004). However, for patients that have psychologic disorders that are controlled, there are some studies that suggest that even these patients have suboptimal weight loss when compared to patients that do not have an Axis I or II diagnosis (according to the Diagnostic and Statistical Manual of Mental Disorders). When offering surgery to these patients, it is important to have active engagement with the patient's psychiatric team for smooth transition and medication monitoring during the perioperative period.

Life Style Risk Factors

There are many modifiable lifestyle factors that can increase a patients risk for perioperative events. Smoking and sedentary lifestyle have been found to be the most directly related to adverse outcomes after surgery [31]. Preoperative education and postoperative follow-up targeted toward addressing these risk factors can mitigate these risks.

Conclusion

Given these risk factors, surgeons should be prepared to evaluate patients not only in regard to the type of surgery offered but also to each patient's individual risk profile. This allows the surgeon to more comprehensively and realistically estimate the amount of risk that each patient is incurring. In addition, the surgical team can be better prepared for complications, should they arise, and have the appropriate consultants involved with the perioperative care of the patient.
True risk seems to be a dynamic interaction between the patient's physical health, medical history, surgeon's skill, type of surgery, operative team's experience, and medical assets available at the medical institution that the surgery is being performed. The very high-risk patients should not necessarily be denied surgery, as long as they can have their surgery at institutions with the capabilities to address the specific factors that make the patient high risk. Further innovations in the surgical treatment for obesity will continue to focus on procedures that decrease risk to patients, while providing excellent long-term weight loss.

Review Questions and Answer

1. Which of the following is not included in the Obesity Mortality Risk Scoring System:

(a) BMI
(b) Age
(c) HTN
(d) Gender
(e) PE risk
(f) Serum creatinine

Answer: f

2. True or False: In published studies, gender has not been found to contribute to increased risk for adverse outcomes

Answer: false

3. Obstructive sleep apnea has been found to be associated with all of the following, except:

(a) Reintubation
(b) Need for mechanical ventilation
(c) Hypoxemia
(d) Transfer to ICU
(e) Prolonged hospital stay
(f) Death

Answer: h

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