Bariatric Surgery in Heart Failure

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7.1 Introduction

Over 6.2 million adults are diagnosed with heart failure (HF), per the most recent National Health and Nutrition Examination Survey (NHANES) report. The prevalence of this disease is estimated to eclipse 8 million adults by the year 2030. Similarly, obesity rates continue to rise, with 39.6% of United States (US) adults diagnosed with obesity (body mass index (BMI) $\geq$ 30 kg/m^2) per the 2015–2016 NHANES data, an increase from 37.7% in 2013–2014. Rates of morbid obesity (BMI $\geq$ 40 kg/m^2) remained stable, though significantly elevated, at 7.7% according to these two reports [1].

Obesity is associated with an increased risk of cardiovascular disease, including HF, coronary artery disease (CAD), and stroke [1]. However, obesity has the strongest association with HF, specifically. Obesity is associated with an almost four-fold (HR 3.73) increase in development of HF in patients with BMI $\geq$ 35 kg/m^2, compared to a two-fold increase in risk of CAD and stroke [2]. Earlier studies noted an "obesity paradox," in which more patients with obesity had a lower all-cause mortality [3–5]. However, further research has shown that this is likely due to lead-time bias: patients with obesity develop cardiovascular disease earlier in life than patients without obesity, and therefore appear to have reduced mortality as they live longer from the time of disease diagnosis [6]. Importantly, this "obesity paradox" does not apply to cardiovascular morbidity, including HF. In fact, BMI is directly related to the risk of incident HF, with increasing risk associated with rising BMI in middle aged men and women: HR 1.23–1.37 for overweight individuals (BMI 25–29.9 kg/m^2), HR 1.95–2.28 for patients with oesity (BMI 30–39.9 kg/m^2), and HR 4.32–5.26 for patients with morbid obesity (BMI $\geq$ 40 kg/m^2) [6]. While obesity confers a

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higher risk of development of both HF with preserved ejection fraction (HFpEF) as well as HF with reduced ejection fraction (HFrEF), there is a higher risk of HFpEF than HFrEF development for each standard deviation increase in BMI. Interestingly, while obesity in men carry an increased risk of both phenotypes of HF, obesity in women only have an increased risk of development of HFpEF, and not HFrEF [7].

Bariatric surgery has become an accepted therapy for morbidly obesity (BMI $\geq$ 40 kg/m^2) without concomitant disease, as well as obesity (BMI $\geq$ 35 kg/m^2) with significant co-morbidities, including cardiovascular risk factors, though not HF specifically [8]. In this chapter, we discuss the effect of bariatric surgery on the incidence of new-onset HF in morbidly obesity, as well as its role in the treatment of known HF. Finally, we will address the unique surgical challenges associated with bariatric surgery in patients with known HF.

7.2 Search Strategy

We aim to assess and review the published data regarding the effect of bariatric surgery on HF outcomes in morbidly obesity, when compared to optimal medical therapy (see Table 7.1). We included the following terms in our search of the PubMed database: "Heart Failure" AND "Bariatric Surgery" OR "Gastric Banding" OR "Gastric Bypass" OR "Gastroduodenal Bypass" OR "Laparoscopic Gastric Bypass" OR "Laparoscopic Gastroduodenal Bypass" OR "Laparoscopic Roux-en-Y Gastric Bypass" OR "Roux-en-Y Gastric Bypass" OR "Sleeve Gastrectomy" OR "surgical weight loss." Search limits included English language, clinical trials, controlled clinical trials, meta-analyses, observational studies, randomized controlled trials, and systemic reviews. The database was searched from inception through December 3, 2019.

7.2.1 Bariatric Surgery Improves Cardiac Function

While there are no trials evaluating bariatric surgery with heart failure incidence as the primary outcome, studies assessing serum biomarkers, invasive hemodynamics, and cardiac function have been completed in this population. First, bariatric surgery is associated with a decrease in Cardiac Troponin-I, an indicator of subclinical myocardial injury, and an increase in N-terminal pro-brain natriuretic peptide, when

Table 7.1 PICO

P (Patients)	I (Intervention)	C (Comparator)	O (Outcomes)
Patients with morbid obesity	Bariatric surgery	Optimal medical therapy	Incidence of new onset heart failure, heart failure hospitalization, cardiovascular mortality, surgical complications

compared to non-surgical weight management [9, 10]. Second, bariatric surgery has been shown to improve the cardiac hemodynamics of obese patients. In a systematic review and meta-analysis of studies evaluating invasive hemodynamics before and after weight loss intervention, three of nine included studies used bariatric surgery as the form of weight loss. The median weight loss of 43 kg in the analysis was associated with significant reduction in heart rate and blood pressure, as well as a significant decrease in invasively measured right atrial pressure, mean pulmonary artery pressure, and pulmonary capillary wedge pressure at both rest and exercise [11].

Additionally, bariatric surgery has been associated with improvements in cardiac structure and function. Two recent systematic reviews and meta-analyses evaluated multiple echocardiographic indicators of cardiac structure and function. These studies showed that weight loss following bariatric surgery led to significant reductions in left ventricular mass index, left ventricular end-diastolic volume, and left atrial size. Furthermore, they noted a significant improvement in left ventricular ejection fraction (LVEF) and echocardiographic indices of diastolic function [12, 13].

7.2.2 Bariatric Surgery Decreases Incidence of Heart Failure

Bariatric surgery has been associated with a decreased incidence of HF. A recent Swedish registry-based study analyzed over 47,000 adult, obese patients to assess the effect of bariatric surgery on incidence of HF. Approximately half of the population underwent bariatric surgery, including gastric banding, vertical banded gastroplasty, and gastroduodenal bypass. There was a five-fold increase in the risk of HF incidence in the non-surgical group when compared to the surgical group, 6.9/1000 person-years compared to 1.0/1000 person-years, respectively. Bariatric surgery conferred a 63% reduction in risk of HF after adjustment for HF risk factors (HR 0.37, 95% CI 0.30–0.46). This reduced risk was significant across age, sex, and comorbidities, including diabetes, hypertension, and CAD [14]. A separate Swedish registry noted a similar significant risk reduction in incident heart failure following gastric bypass surgery (HR 0.54, 95% CI 0.35–0.82), over a median 4.1 years of follow-up. This risk reduction was in the setting of an additional 22.6 kg weight loss after 2-year follow-up in the surgical cohort compared to the lifestyle modification cohort [15].

7.2.3 Bariatric Surgery Reduces Morbidity and Improves Cardiac Function in Heart Failure Patients

There are no randomized control trials evaluating bariatric surgery versus placebo in patients with HF. However, there are multiple, small observational studies indicating bariatric surgery is associated with an improvement in HF symptoms and functional status, as well as a decrease in HF hospitalization [16–20].

HF symptoms and functional status have been shown to improve with bariatric surgery in HF patients. In a small retrospective review of 12 morbidly obese patients with HFrEF undergoing bariatric surgery, New York Heart Association (NYHA) functional class improved significantly in the surgical group, 2.9 ± 0.7 to 2.3 ± 0.5 (p = 0.02), and worsened significantly in the control group, 2.4 ± 0.7 to 3.3 ± 0.9 (p = 0.02) [16]. Similar improvement in NYHA functional class was noted among 14 patients with morbid obesity that underwent bariatric surgery, including laparoscopic and open Roux-en-Y gastric bypass, sleeve gastrectomy, and laparoscopic gastric banding. At baseline, 43%, 43%, and 14% of patients had NYHA class II, III, and IV functional status, respectively. Post-operatively, this improved to 86%, 14%, and 0%, respectively [18]. In another small retrospective study, 13 patients with HFrEF underwent bariatric surgery and six received non-operative weight management, after which surgery was associated with improved symptoms. Over 4.3 ± 2.7 years of follow-up, the surgical patients had improved dyspnea on exertion and lower extremity edema when compared to the non-surgical controls [17].

These data also indicate an improvement in LVEF in HF patients following bariatric surgery. In the retrospective study by Ramani et al., baseline LVEF increased significantly in the surgical group, from 21.7 ± 6.5% to 35 ± 14.8% (p = 0.005), but not in the ten matched control non-surgical patients, LVEF 23.5 ± 6.7% to 28.5 ± 14.0% (p = 0.25) [16]. McCloskey et al. reported similar improvement in LVEF, from 23 ± 2% to 32 ± 4% in HF patients with morbid obesity following bariatric surgery [18]. Finally, this improvement in LVEF was also seen in a larger retrospective study of 42 patients with obesity and LVEF <50% in which bariatric surgery was associated with a significant increase in LVEF (5.1 ± 8.3%, p = 0.0005). Comparatively, a matched cohort of HF patients with obesity that did not undergo bariatric surgery had a non-significant improvement in LVEF (3.4 ± 10.5%, p = 0.056) [19].

HF hospitalizations are one of the major sources of morbidity for HF patients [1]. Importantly, bariatric surgery has been associated with reduced HF hospitalizations in this population. In the study by McCloskey et al., five of the 14 patients were hospitalized for a HF exacerbation in the 6 months prior to surgery, while none were hospitalized in the 6 months following surgery [18]. Furthermore, in their retrospective case series, Ramani et al. showed a significant reduction in HF hospitalizations in the first year following bariatric surgery when compared to the control group (0.4 ± 0.8 vs 2.4 ± 2.6, p = 0.04) [16]. Finally, a large, retrospective case series of 524 HF patients that underwent bariatric surgery indicated a non-significant reduction in emergency department visits for HF exacerbations in the first 12 months following surgery when compared to the 12 months prior to surgery (15.3% to 12%, p = 0.052). However, there was a significant reduction during the following year (post-operative months 13–24), with a reduction from 15.3% to 9.9%, adjusted OR 0.57, p = 0.003) [21]. While there are no prospective studies evaluating the effects of bariatric surgery on HF, the published data indicate positive effects on cardiac function, patient symptoms, and heart failure hospitalizations.

7.2.4 Heart Failure Patients Are Not at Increased Risk for Major Bariatric Surgical Complications

Non-cardiac surgery in HF patients is associated with an increased risk of re-hospitalization and mortality [22]. However, the limited published data regarding bariatric surgery in this specific population suggests its relative safety. In a cohort of 14 patients with average BMI 50.8 ± 2.04 kg/m^2 and LVEF 23 ± 2%, bariatric surgery, including laparoscopic and open Roux-en-Y gastric bypass, sleeve gastrectomy, and laparoscopic gastric banding, surgical complications included one patient with pulmonary edema, one patient with hypotension, and two patients with acute renal injury. There were no incidences of peri-operative myocardial infarction or mortality [18]. Similar data were noted in a retrospective evaluation for 32 patients with diagnosed HF prior to Roux-en-Y gastric bypass surgery. Again, there were no incidences of peri-operative myocardial infarction or mortality. However, one patient was re-admitted on post-operative day (POD) #3 for gastrointestinal bleeding in the setting of a supratherapeutic INR related to warfarin used. The patient died of an anoxic brain injury on POD #6 [23]. A larger retrospective study of 2630 obese patients, of which 42 had an LVEF <50%, indicated significantly more post-operative HF exacerbations and post-operative myocardial infarctions, although numerically these were small numbers; there were only four HF exacerbations and one post-operative myocardial infarction among the 42 patients with reduced EF. Notably, there were no differences between the groups in intensive care unit stay, hospital stay, 30-day mortality, or 12-month mortality [19]. In fact, reported average length of stay post-operatively was 3 days, consistent with the literature in obese patients without HF [18, 23–25].

It is important to note that these are limited data, and many of these patients were aggressively optimized for surgery. For instance, in the case series by Ramani et al., seven of the 12 patients were admitted prior to surgery for invasive hemodynamic assessment and optimization. Additionally, all 12 patients spent the first post-operative day in the cardiac intensive care unit for monitoring [16]. There are limited data reported on peri-operative management of HF patients for bariatric surgery specifically, however it is important to follow established guidelines for pre-operative and peri-operative management of patients with HF undergoing non-cardiac surgery [22].

7.3 Recommendations Based on Data

The published data suggest that cardiac function and the incidence of HF are reduced in morbidly obese patients following bariatric surgery. There are a lack of prospective, randomized trials, and therefore, these data should be categorized as moderate quality, with a low risk of bias due to the large number of patients included without significant heterogeneity in results. Additionally, the published data indicate that bariatric surgery is associated with improved morbidity and cardiac

Table 7.2 Evidence and recommendations

Supposed advantage of bariatric surgery	Grade of evidence	Recommendation	Strength of recommendation
Reduction in risk of incident HF	Moderate quality	Bariatric surgery likely reduces the risk of incidence of HF in the morbidly obese patients without a prior diagnosis of HF	Strong
Improvement in cardiac function for patients with HF	Weak quality	Bariatric surgery may improve cardiac function in morbidly obese patients regardless of prior HF diagnosis	Weak
Improvement in functional status for patients with HF	Weak quality	Bariatric surgery may improve functional status in morbidly obese patients with prior history of HF	Weak
Reduction in HF hospitalization	Weak quality	Bariatric surgery may reduce frequency of HF hospitalizations in patients with prior history of HF	Weak
Reduction in cardiovascular mortality for HF or non-HF patients	NA	There are no reliable published data addressing cardiovascular mortality in morbidly obese patients following bariatric surgery	NA
Bariatric surgery is safe in HF patients	Weak quality	Limited data suggest bariatric surgery is safe in HF patients when pre-operative and peri-operative care is provided per the ACC/AHA guidelines for non-cardiac surgery [22].	Weak

function in patients with morbidly obesity and HF. However, these small, observational studies should be categorized as low quality with a high risk of bias due to the limited numbers of patients included. However, the consistency across these studies indicate higher likelihood of a true association between bariatric surgery and these positive outcomes (Table 7.2).

7.4 Personal View of the Data

HF is an increasingly common worldwide disease, as is obesity. These two diseases are intertwined, as the risk of HF development is increased in patients with obesity, while obesity also worsens morbidity amongst HF patients. The significant weight loss associated with bariatric surgery, when compared to usual care, has shown positive effects in the cardiovascular health of patients both with and without HF. These positive effects are apparent from improvements in baseline cardiac function and hemodynamics, to clinical outcomes such as functional status and HF hospitalization. While to date there are limited data on this specific population undergoing bariatric surgery, in aggregate, bariatric surgery appears to improve HF-related outcomes for patients with morbidly obesity and without known HF, as well as improve cardiovascular outcomes for patients with morbidly obesity and HF. We anticipate that further studies in this field will reinforce the signal for positive outcomes.

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