Safety and Efficacy of Bariatric Surgery in Morbidly Obese Patients with Severe Systolic Heart Failure

Address for correspondence:
Gautam V. Ramani, MD
200 Lothrop St., Scaife Hall
Suite 5B, Cardiovascular Institute
University of Pittsburgh
Medical Center
Pittsburgh, PA 15213, USA
gvr001@yahoo.com

Gautam V. Ramani, MD,* Carol McCloskey, MD,† Ramesh C. Ramanathan, MD,† Michael A. Mathier, MD*

*Cardiovascular Institute; †Bariatric Surgery Program, University of Pittsburgh Medical Center Pittsburgh, Pennsylvania, USA

ABSTRACT

Background: Morbid obesity (MO) is a risk factor for congestive heart failure (CHF). The presence of MO impairs functional status and disqualifies patients for cardiac transplantation. Bariatric surgery (BAS) is a frontline, durable treatment for MO; however, the safety and efficacy of BAS in advanced CHF is unknown.

Hypothesis: We hypothesized that by utilizing a coordinated approach between an experienced surgical team and heart failure specialists, BAS is safe in patients with advanced systolic CHF and results in favorable outcomes.

Methods: We performed a retrospective chart review of 12 patients with MO (body mass index [BMI] 53 ± 7 kg/m^2) and systolic CHF (left ventricular ejection fraction [LVEF] 22 ± 7%, New York Heart Association [NYHA] class 2.9 ± 0.7) who underwent BAS, and then compared outcomes with 10 matched controls (BMI 47.2 ± 3.6 kg/m^2, LVEF 24 ± 7%, and NYHA class 2.4 ± 0.7) who were given diet and exercise counseling.

Results: At 1 y, hospital readmission in BAS patients was significantly lower than controls (0.4 ± 0.8 versus 2.5 ± 2.6, $p = 0.04$); LVEF improved significantly in BAS patients (35 ± 15%, $p = 0.005$), but not in controls (29 ± 14%, p = not significant [NS]). The NYHA class improved in BAS patients (2.3 ± 0.5, $p = 0.02$), but deteriorated in controls (3.3 ± 0.9, $p = 0.02$). One BAS patient was successfully transplanted, and another listed for transplantation.

Conclusions: Bariatric surgery is safe and effective in patients with MO and severe systolic CHF, and should be considered in patients who have failed conventional therapy to improve clinical status.

Key words: bariatric surgery, morbid obesity, congestive heart failure, metabolic cardiomyopathy

Introduction

Morbid obesity (MO) is an increasingly prevalent chronic metabolic disorder associated with multiple comorbidities.[1] In the general population, long-standing obesity is a risk factor for heart failure even in the absence of traditional risk factors for coronary artery disease, and is an independent risk factor for mortality.[2,3] Over time, MO results in structural myocardial changes, including increased left ventricular (LV) dimensions and mass, and impaired LV relaxation and systolic function.[4,5] The mechanisms underlying these changes remain poorly understood.

Surprisingly, in spite of observations that obesity is a risk factor for the development of heart failure, very little is known regarding outcomes of patients with MO and established heart failure. Although many have been surprised by data suggesting that modest obesity is protective in patients with heart failure, both MO and heart failure markedly reduce functional capacity.[6,7] Anecdotally, patients with the combination of these 2 conditions have severe functional limitation and poor survival. In addition, the presence of advanced heart failure makes weight loss by conventional means nearly impossible for obese patients. Lastly, the presence of MO generally disqualifies patients from consideration for cardiac transplantation.

Bariatric surgery (BAS) has emerged as a safe, effective, and durable treatment for MO.[8] Advances in minimally invasive surgery have shortened recovery time, reduced peri-operative morbidity, and expanded the range of patients amenable to this procedure.[9] While previous studies have demonstrated that marked weight reduction following BAS results in a reduction in LV mass and improved diastolic filling,[10] outcomes of patients with severe systolic heart failure following BAS have not been previously reported.

Methods

We queried the Heart Failure Clinic database of the University of Pittsburgh Medical Center (Pittsburgh, Penn., USA) for all patients with advanced systolic heart failure and MO. We identified 12 such patients who underwent BAS from 2001–2006. We also identified a cohort of 10 age-, sex-, and body mass index (BMI)-matched controls who did not undergo BAS. These patients received standard recommendations regarding calorie-restricted diet and exercise. To control for lead-time bias, we charted the time from the diagnosis of cardiomyopathy to either enrollment into our database or to BAS. The primary safety analysis was to assess the frequency and type of operative complications, and the number of readmissions to the hospital in the

Clin. Cardiol. 31, 11, 516–520 (2008)
Published online in Wiley InterScience. (www.interscience.wiley.com)
DOI:10.1002/clc.20315

Received: July 12, 2007
Accepted with revision: September 17, 2007

subsequent 12 mo. The primary efficacy analysis was to determine the effect of BAS on BMI, left ventricular ejection fraction (LVEF), and New York Heart Association (NYHA) functional class. Left ventricular ejection fraction was assessed by echocardiography, and was determined visually by an independent reader. When LVEF was reported as a range, the mean value was used in the analysis. The NYHA functional class was qualitatively determined by a heart failure physician in the outpatient clinic, and when NYHA was recorded as a range, the higher estimate was used.

Continuous variables were expressed as mean±standard deviation (SD), and t-tests were used to determine statistical significance. The Chi-square test was used to determine the significance of categorical variables. For all analyses, a 2-tailed p-value of <0.05 was considered statistically significant. All analyses were performed using SPSS version 14.0 for Windows (SPSS, Inc., Chicago, Ill., USA).

Results

Of the 12 patients undergoing surgery, 8 patients had laparoscopic Roux-en-Y bypass, 2 patients underwent laparoscopic sleeve gastroplasty, 1 patient underwent laparoscopic gastric banding, and 1 patient required conversion to an open

TABLE 1: Baseline characteristics

Characteristic	BAS (n = 12)	Control (n = 10)	p-value
Age (y)	41±10	45±9	0.30
Lead-time (y)	6.0±4.9	4.3±4.5	0.41
BMI (kg/m²)	53±7	47±4	0.02
Nonischemic (no.)	10	8	0.84
NYHA Class	2.9±0.7	2.4±0.7	0.72
LVEF (%)	22±7	24±7	0.52
Male (no.)	3	4	0.52
Diabetes (no.)	6	6	0.64
Inotropes (no.)	2	4	0.22
Sleep apnea (no.)	6	5	0.90
Atrial fibrillation (no.)	6	6	0.86
Hypertension (no.)	9	6	0.38
ICD (no.)	7	7	0.92
Heart rate pm (b)	73±9	74±9	0.94
Systolic blood pressure (mm Hg)	110±13	107±6	0.45
Diastolic blood pressure (mm Hg)	74±9	68±9	0.16
Sodium (mg/dL)	138±3	137±2	0.32
Creatinine (mg/dL)	1.2±0.3	1.4±0.6	0.38
Hemoglobin (g)	13.3±1.5	12.2±0.9	0.07
ß-blocker (no.)	8	9	0.32
ACE inhibitor/ angiotensin II receptor blocker (no.)	11	7	0.19
Digoxin (no.)	8	6	0.54
Spironolactone (no.)	5	5	0.70

Abbreviations: ACE = angiotensin-converting enzyme; BMI = body mass index; ICD = implantable cardioverter-defibrillator; LVEF = left ventricular ejection fraction; NYHA = New York Heart Association.

Roux-en-y bypass. Baseline characteristics of the surgical and control groups are listed in Table 1. There was a modest but statistically significant higher BMI in the surgery group at baseline (53±7 versus 47±4 kg/m^2, $p = 0.03$). There was no significant difference in the duration of congestive heart failure (CHF) between the 2 groups. The groups were well matched with respect to traditional cardiovascular risk factors and medical comorbidities. No baseline differences were noted in age, sex, NYHA class, LVEF, serum creatinine, sodium, or hemoglobin.

In the surgical cohort, the median length of hospital stay was 3.0±1.5 d, which compares favorably with published reports for laparoscopic BAS.[11] In the postoperative period, 1 patient developed transient pulmonary edema and another had acute renal failure, which required hospital readmission and resolved with hydration. There were no postoperative myocardial infarctions or anastamotic leaks.

Outcomes at 12 mo are listed in Table 2. Body mass index decreased markedly in the surgical cohort, and did not change in the medical therapy group. Overall, there were significant improvements in both LVEF and NYHA class in the surgical cohort as compared with the controls (Figures 1 and 2). There was a trend to a reduction in LV size in the surgical cohort that did not reach statistical significance. The surgical cohort had fewer CHF and all-cause admissions to the hospital. There were no significant changes in either group in laboratory parameters or cardiovascular medications, with the exception of the surgical group having a significant reduction in diuretic use. Two patients in the surgical cohort were placed on the waiting list for cardiac transplantation, and 1 patient successfully underwent the procedure.

Discussion

Morbid obesity is defined as a BMI ≥40 kg/m^2 and is rapidly increasing in prevalence.[1] While obesity is an important risk factor for the development of heart failure,[12,13] the relationship between CHF and obesity is complex.[14,15] Observational studies suggest the risk of developing CHF is correlated with both the duration and the severity of obesity.[12] Morbid obesity is widely recognized to be a challenging condition to treat, and is made even more difficult to manage by the presence of CHF. Patients with CHF already face dietary restrictions, and generally have markedly limited exercise tolerance, frequently resulting in

TABLE 2: One-year outcomes

	BAS			Control		
Characteristic	Baseline	Follow-up	p-value	Baseline	Follow-up	p-value
BMI (kg/m^2)	53±7	38±8	<0.01	47±4	48±3	0.56
NYHA class	2.9±0.7	2.3±0.5	0.02	2.4±0.7	3.3±0.9	0.02
LVEF (%)	21.7±6.5	35.0±14.8	<0.01	23.5±6.7	28.5±14.0	0.25
LV diastolic diameter (cm)	6.4±0.6	5.5±0.9	0.08	6.6±0.6	6.4±0.8	0.96
Left atrial size (cm)	4.9±0.6	5.0±0.8	0.94	4.8±0.7	5.1±0.7	0.92
CHF Admissions (no.)		0.42±0.67			2.4±2.6	0.04
Reduction in diuretic dose (no.)		11			1	<0.01
Diabetes	6	4	0.82	6	6	1.0
Sleep apnea	6	5	0.87	5	5	1.0
Heart rate (bpm)	73±9	79±18	0.85	74±9	81±15	0.81
Systolic blood pressure (mm Hg)	110±13	113±13	0.92	107±6	116±13	0.24
Diastolic blood pressure (mm Hg)	74±9	70±9	0.84	68±9	69±10	0.94
Sodium (mg/dL)	138±3	138±4	0.40	137±2	135±5	0.37
Creatinine (mg/dL)	1.2±0.31	1.3±1.0	0.63	1.4±0.63	1.8±1.0	0.15
Hemoglobin (g)	13.3±1.5	13.1±1.5	0.29	12.2±0.92	11.7±1.4	0.52

Abbreviations: BMI = body mass index; CHF = congestive heart failure; LV = left ventricular; LVEF = left ventricular ejection fraction; NYHA = New York Heart Association.

Published online in Wiley InterScience. (www.interscience.wiley.com)
DOI:10.1002/clc.20315

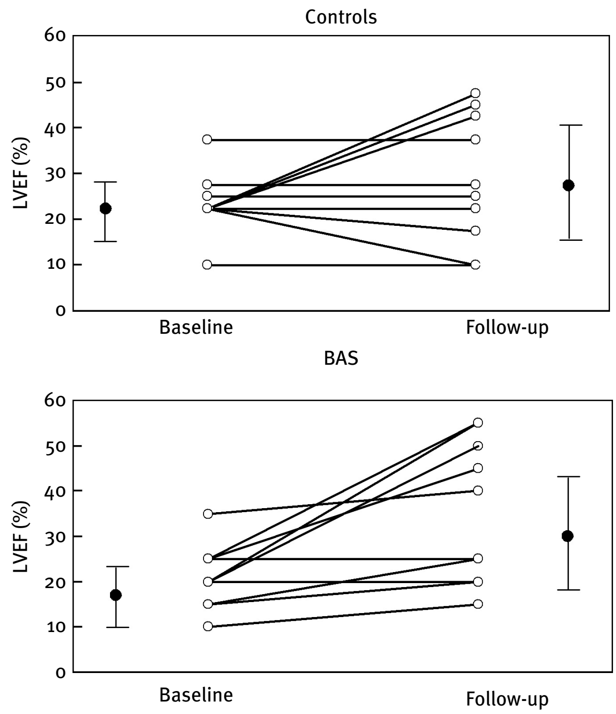

Figure 1: One-year change in LVEF (%).

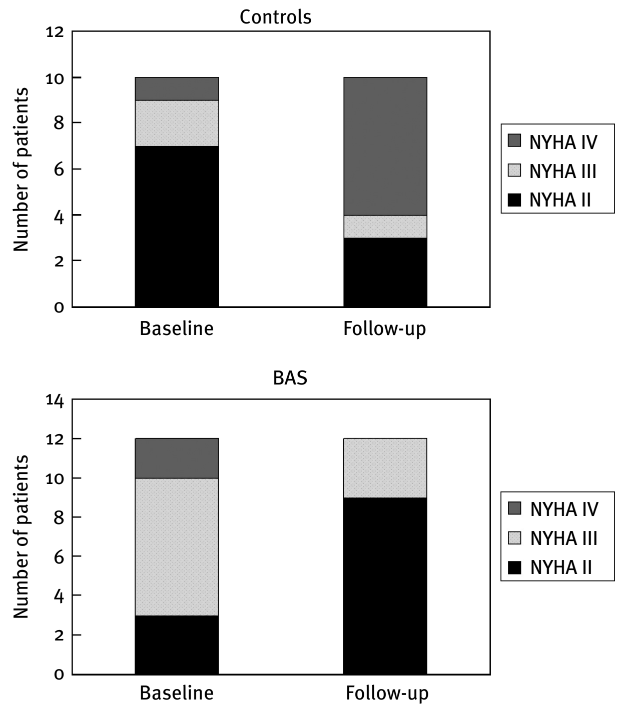

Figure 2: One-year change in NYHA functional class.

a cycle of worsening obesity, CHF symptomatology, and functional limitation.

Multiple studies have documented the myocardial effects of obesity, even in the absence of overt CHF. Recent studies have documented alterations in chamber thickness, LV diameter and LV mass, increased isovolemic relaxation time, and impaired ventricular filling as documented by mitral inflow velocities.[16] Both the duration and the severity of obesity appear to play a role in these morphological changes. Substantial weight loss, including BAS, does improve these parameters, but this has not been studied in advanced systolic heart failure.[17]

Whereas medical therapy and lifestyle modification have had disappointing long-term results in the treatment of MO, BAS has emerged as an effective treatment option.[18] Safety concerns have limited the use of BAS in patients with advanced CHF, and most BAS studies have excluded such patients. Our data, however, suggest that the procedure is safe when performed by an experienced team. Our low incidence of peri-operative complications is most likely related to a system of coordinated care between surgeons and cardiologists. Prior to surgery, 7 of 12 patients were electively admitted to the hospital and underwent right heart catheterization. For all patients, hemodynamics and pharmacotherapy were optimized prior to surgery, and the initial postoperative day was spent in the coronary intensive care unit.

In our study, we observed significant improvements in LVEF and NYHA class in the surgical cohort. The LVEF is an imperfect, though commonly used, marker of cardiac performance: it correlates poorly with functional status in CHF, and accurate measurement of LVEF is challenging in obese patients. Despite these limitations, our finding of improved LVEF following BAS is provocative, and builds on previous reports of improved LV geometry and diastolic performance following weight loss in patients with MO, CHF, and preserved LVEF. Similarly, while NYHA class is commonly used to assess functional severity in patients with CHF, this also has its limitations: noncardiac issues may significantly affect NYHA class. In patients with MO, musculoskeletal and pulmonary limitations commonly impair function. Accordingly, some of the improvements seen in NYHA class in our surgical patients may reflect improvement in these areas in addition to improved cardiac performance.

Multiple potential mechanisms may explain the observed improvements in cardiac performance following BAS. Improvements in cardiac loading conditions, including resolution of hypertension following BAS, has been reported.[19] Improvements in both neuroendocrine and cytokine profiles have been described following BAS.[20,21] Patients with MO have abnormal circulating levels of a variety of adipocyte-associated cytokines, including leptin,[22] and normalization of cytokine profiles has been described following surgery.[21]

These complex neurohormal and neuroendocrine relationships will need to be further explored in future prospective studies.

It is highly significant that in the year following BAS, 1 patient successfully underwent cardiac transplantation and another was listed for cardiac transplantation. Despite advances in medical and device therapy for patients with CHF, mortality remains unacceptably high[23] and cardiac transplantation remains the most durable therapy for patients with advanced CHF, with a 10-y survival approaching 50%.[24] Therefore, BAS may be considered as a bridge to transplantation in patients with advanced heart failure who would otherwise not be considered surgical candidates.

Despite these findings, our study has several important limitations. Our study group was small and was examined retrospectively. The majority of patients included had nonischemic cardiomyopathy, so caution must be exercised when generalizing these results to all patients with systolic dysfunction. We specifically excluded patients with preserved LVEF. Although we attempted to obtain a control group that was similar to our surgical group, there was a modest, though statistically significant, difference in baseline BMI, and we cannot exclude the possibility that selection bias may have affected these findings. We did not measure serum brain natriuretic peptide, cytokine levels, or objective functional capacity, such as 6-min walk distance or maximal oxygen consumption. These may have provided additional insight into the degree and mechanisms of improvement in cardiac performance and functional status observed following surgery.

Conclusions

The present work suggests that BAS is a safe, effective, and durable treatment of MO in patients with advanced systolic heart failure who have not responded to conventional therapy. Prospective studies are needed to further clarify the optimal timing for BAS in systolic CHF, and to provide additional mechanistic insight into the observed findings.

Acknowledgements

The authors report no conflicts of interest.

References

1. Freedman DS, Khan LK, Serdula MK, Galuska DA, Dietz WH: Trends and correlates of class 3 obesity in the United States from 1990 through 2000. *JAMA* 2002;288:1758–1761
2. Calle EE, Thun MJ, Petrelli JM, Rodriguez C, Heath CW: Body-mass index and mortality in a prospective cohort of U.S. Adults. *N Engl J Med* 1999;341:1097–1105
3. Wison PW, D'Agostino RB, Sullivan L, Praise H, Kannel WB: Overweight and obesity as determinants of cardiovascular risk: the Framingham experience. *Arch Intern Med* 2002;162:1867–1872
4. Alpert MA, Lambert CR, Terry BE, Cohen MV, Mukerji V, et al.: Influence of left ventricular mass on left ventricular diastolic filling in normotensive morbid obesity. *Am Heart J* 1995;130:1068–1073
5. Alpert MA, Lambert CR, Panayiotou H, Terry BE, Cohen MV, et al.: Relation of duration of morbid obesity to left ventricular mass, systolic function, diastolic filling, and effect of weight loss. *Am J Cardiol* 1995;76:1194–1197
6. Lavie CJ, Osman AF, Milani RV, Mehra MR: Body composition and prognosis in chronic systolic heart failure: The obesity paradox. *Am J Cardiol* 2003;99:891–894
7. Gallagher MJ, Franklin BA, Ehrman JK, Keteyian SJ, Brawner CA, et al.: Comparative impact of morbid obesity vs heart failure on cardiorespiratory fintness. *Chest* 2005;127:2197–2203
8. Buchwald H, Avidor Y, Braunwald E, Jensen MD, Porles W, et al.: Bariatric surgery: a systematic review and meta-analysis. *JAMA* 2004;292:1724–1737
9. Nguyen NT, Root J, Zainabadi K, Sabio A, Chalifoux S, et al.: Accelerated growth of bariatric surgery with the introduction of minimally invasive surgery. *Arch Surg* 2005;140:1198–1202
10. Poirier P, Martin J, Picard M, Biron S, Marceau S: Impact of bariatric surgery on cardiac structure, function and clinical manifestations in morbid obesity. *Expert Rev Cardiovasc Ther* 2004;2:193–201
11. Gould JC, Garren MJ, Boll V, Starling JR: Laparoscopic gastric bypass: risk vs benefits up to two years following surgery in super-super obese patients. *Surgery* 2006;140:524–529
12. Kenchaiah S, Evans J, Levy D, Wilson PW, Benjamin EJ, et al.: Obesity and the risk of heart failure. *N Engl J Med* 2002;347:305–313
13. He J, Ogden LG, Bazzano LA, Vupputuri S, Loria C, et al.: Risk factors for congestive heart failure in the elderly: a prospective community-based study. *Am J Med* 1999;106:605–612
14. Kenchaiah S, Gaziano J, Vasan R: Impact of obesity on the risk of heart failure and survival after the onset of heart failure. *Med Clin North Am* 2004;88:1273–1294
15. Ingelsson E, Arnolv J, Sundstrom J, Zethelius B, Vessby B, et al.: Novel metabolic risk factors for heart failure. *J Am Coll Cardiol* 2005;46:2054–2060
16. Wang CY, O'moore-Sullivan T, Leano R, Byrne N, Beller E, et al.: Alterations of left ventricular myocardial characteristics associated with obesity. *Circulation* 2004;110:3081–3087
17. Himeno E, Nishino K, Nakashima Y, Kuroiwa A, Ikeda M: Weight reduction regresses left ventricular mass regardless of blood pressure level in obese subjects. *Am Heart J* 1996;131:313–319
18. Nguyen NT, Goldman C, Rosenquist CJ, Arango A, Cole CJ, et al.: Laparoscopic versus open bypass: a randomized study of outcomes, quality of life, and costs. *Ann Surg* 2001;234:279–291
19. Fernstrom JD, Courcoulas AP, Houck PR, Fernstrom MH: Long-term changes in blood pressure in extremely obese patients who have undergone bariatric surgery. *Arch Surg* 2006;141:276–283
20. Ruano M, Silvestre V, Castro R, Garcia-Lescun MC, Rodriguez A, et al.: Morbid obesity, hypertensive disease and the rennin angiotensin aldosterone axis. *Obes Surg* 2005;15:670–676
21. Ramos AP, de Abreu MR, Vendramini RC, Brunetti IL, Pepato MT: Decrease in circulating glucose, insulin and leptin levels and improvement in insulin resistance at 1 and 3 months after gastric bypass. *Obes Surg* 2006;16:1359–1364
22. Schuze PC, Kratzsch J, Linke A, Schoene N, Adams V, et al.: Elevated serum levels of leptin and soluble leptin receptor in patients with advanced chronic heart failure. *Eur J Heart Fail* 2003;5:33–40
23. Mosterd A, Cost B, Hoes AW, de Bruijne MC, Deckers JW, et al.: The prognosis of heart failure in the general population: The Rotterdam Study. *Eur Heart J* 2001;22:1318–1327
24. Taylor DO, Edwards LB, Boucek MM, Trulock EP, Deng MC, et al.: Registry of the International Society for Heart and Lung Transplantation: twenty-second official adult heart transplant report–2005. *J Heart Lung Transplant* 2005;24:945–955

Published online in Wiley InterScience. (www.interscience.wiley.com)
DOI:10.1002/clc.20315