Case Series

Effect of Laparoscopic Sleeve Gastrectomy on Heart Transplant Status

in 4 Patients with Left Ventricular Assist Devices

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Bariatric surgery helps many morbidly obese patients lose substantial weight. However, few data exist on its long-term safety and effectiveness in patients who also have continuous-flow left ventricular assist devices and in whom heart transplantation is contemplated. We retrospectively identified patients at our institution who had undergone ventricular assist device implantation and subsequent laparoscopic sleeve gastrectomy from June 2015 through September 2017, and we evaluated their baseline demographic data, preoperative characteristics, and postoperative outcomes.

Four patients (3 men), ranging in age from 32 to 44 years and in body mass index from 40 to 57, underwent sleeve gastrectomy from 858 to 1,849 days after left ventricular assist device implantation to treat nonischemic cardiomyopathy. All had multiple comorbidities.

At a median follow-up duration of 42 months (range, 24–47 mo), median body mass index decreased to 31.9 (range, 28.3–44.3) at maximal weight loss, with a median percentage of excess body mass index lost of 72.5% (range, 38.7%–87.4%). After achieving target weight, one patient was listed for heart transplantation, another awaited listing, one was kept on destination therapy because of positive drug screens, and one regained weight and remained ineligible.

On long-term follow-up, laparoscopic sleeve gastrectomy appears to be safe and feasible for morbidly obese patients with ventricular assist devices who must lose weight for transplantation consideration. Additional studies are warranted to evaluate this weight-loss strategy after transplantation and immunosuppression. ***(Tex Heart Inst J 2020;47(4):284-9)***

Key words: *Adaptation, physiological; body mass index; cardiovascular diseases/physiopathology; gastrectomy/methods; heart failure/complications; heart-assist devices/adverse effects; obesity/complications/physiopathology; obesity, morbid/complications/surgery; retrospective studies; treatment outcome*

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The prevalence of obesity, a serious metabolic disorder, has increased worldwide for decades. It is an important independent risk factor for cardiovascular disease and is associated with other metabolic comorbidities that are also cardiovascular risk factors. Obesity has been directly associated with left ventricular (LV) hypertrophy, dilation, and adverse remodeling, all known precursors of heart failure (HF).[1,2] Morbid obesity, defined as a body mass index (BMI) of ≥40 or of ≥35 with systemic obesity-related comorbidities, complicates HF management and contributes to perioperative morbidity and death after cardiac surgery.[3,4]

Heart transplantation (HT) has emerged as the definitive treatment for end-stage cardiac disease that is refractory to medical and mechanical therapy.[5] Because of limited organ allocation and the increased morbidity and decreased graft survival in obese HT recipients, the 2006 International Society of Heart and Lung Transplantation (ISHLT) guidelines included weight loss to a BMI of <35 before listing for HT.[6] The guideline updates in 2016 included a more stringent BMI of <30 or a percent ideal body weight of <140%.[7] Many patients benefit from mechanical circulatory support from LV assist devices (LVADs), which improve survival rates and can serve as a bridge to transplantation. However, BMI typically fails to improve after LVAD implantation, and difficulties related to obesity and BMI cause higher complication rates after LVAD placement.[8-12]

Bariatric surgery safely enables substantial weight loss in morbidly obese patients; however, it is not often performed in patients who have LVADs, probably because of perceived perioperative risk.[13] In the several published case series of bariatric surgery in LVAD patients, long-term follow-up data are lacking. We present a case series of 4 patients who underwent laparoscopic sleeve gastrectomy (LSG) while on LVAD support, and we provide longer-term follow-up data than those in prior studies.

Patients and Methods

After Institutional Review Board approval, we retrospectively analyzed the cases of 4 patients who had end-stage HF managed with continuous-flow LVADs and who later underwent laparoscopic sleeve gastrectomy (LSG). All had BMIs higher than the ISHLT 2006 minimum cutoff for HT, and all met the 1991 National Institutes of Health Consensus Criteria for weight-loss surgery. Three different bariatric surgeons performed the LSG procedures from June 2015 through September 2017, using general anesthesia, endotracheal intubation, and optical trocar insertion through the peritoneum, in addition to establishing the standard 4 working ports.

We collected each patient's demographic data, HF cause, LV ejection fraction, and New York Heart Association (NYHA) functional class status. We compared preoperative and postoperative weight, BMI, and postoperative percentage of excess BMI lost (%EBMIL), and evaluated operative details, length of hospital stay, postoperative complications, and HT candidacy. Our data are presented as median and range.

Results

The 4 patients (3 men) had a median age of 40 years (range, 32–44 yr), and a median BMI of 45 (range, 40–57). Three had a HeartWare HVAD (Medtronic), and one had a HeartMate II LVAD (Abbott), all to treat nonischemic cardiomyopathy. The median time from LVAD implantation to LSG was 992 days (range, 858–1,849 d) (Table I). Table II shows their comorbidities.

The median operative time for LSG was 105 minutes (range, 60–128 min) (Table III). Perioperative anticoagulation and antiplatelet therapy was managed individually (Table IV). Two patients stopped taking warfarin several days before LSG, to enable a normal international normalized ratio (INR). Patient 3's infusion of low-molecular-weight heparin, begun during preoperative admission for a subtherapeutic INR, was discontinued 24 hours before LSG. Patient 4 had declined systemic anticoagulation. Antiplatelet therapy was discontinued in Patients 2 and 4 before LSG and was restarted within one postoperative day (POD).

All the patients underwent successful LSG procedures, uncomplicated by thromboembolism and gastrointestinal leaks or obstructions. Two had in-hospital bleeding (Table III): Patient 1 had a subdural hemorrhage on POD 3 (managed nonoperatively), and Patient 3 had an intra-abdominal hematoma on POD 1 (3 units of packed red blood cells were transfused). Their anticoagulation therapy was later resumed without incident. The median length of hospital stay was 6 days (range, 4–22 d), with no 30-day readmissions or major complications secondary to LSG.

During follow-up, 2 patients underwent LVAD exchange. Patient 4 had outflow-graft thrombosis 485 days after LSG. Patient 3 had subacute pump thrombosis 657 days after LSG. Of note, significant adhesions in Patient 3's upper abdomen greatly complicated device removal from its thoracoabdominal position, so a HeartMate 3 intrapericardial LVAD was implanted before staged removal of the thrombosed LVAD 3 days later.

At 6 months after LSG, all the patients had lost substantial weight (Fig. 1). At 24 months, the median BMI decreased to 33.2 (range, 29.6–50.3) at maximal weight loss; median %EBMIL was 72.5% (range, 38.7%–87.4%) (Table V). At last follow-up (median, 42

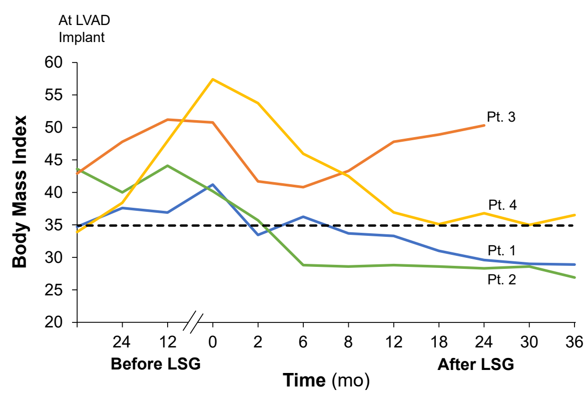

Fig. 1 *Graph shows body mass index (BMI) values before and after laparoscopic sleeve gastrectomy (LSG). Patient 3 had accrued only 24 months after LSG. The dotted line indicates the BMI cutoff of ≤35 for cardiac transplantation at our institution.*

LVAD = left ventricular assist device; Pt. = patient

TABLE I. Patient Characteristics at Time of Laparoscopic Sleeve Gastrectomy

Patient	Age (yr), Sex	NYHA Functional Class	LVAD Type	LVAD Support (d)	Body Mass Index
1	43, M	III	HeartWare	1,106	43.3
2	37, M	III	HeartWare	878	40.2
3	44, F	II	HeartMate II	858	45.7
4	32, M	I	HeartWare	1,849	57.4

F = female; LVAD = left ventricular assist device; M = male; NYHA = New York Heart Association mo; range, 24–47 mo), Patient 2 had achieved target weight and was listed for HT, and Patient 4 awaited listing (Table VI). Patient 1 was continued on LVAD support as destination therapy because of drug screens positive for opioids and cocaine, and Patient 3 began regaining weight 6 months after LSG and had a BMI >35. Three patients were in NYHA functional class I, and one was in NYHA class II.

TABLE II. Comorbidities in the 4 Patients

Comorbidity	Patients (n)
Hypertension	4
Former smoker	3
Diabetes mellitus	3
Chronic kidney disease	3
Cerebrovascular accident	3
Atrial fibrillation	2
Hyperlipidemia	1

Discussion

Heart failure is epidemic in the United States, affecting more than 5.8 million adults.[14] The gold standard for treating patients with end-stage HF is HT, but it is not recommended in patients with morbid obesity. In these patients, mechanical circulatory support may be needed because of cardiac status; however, LVAD implantation can lead to weight gain and exacerbate HF symptoms and progression.[15-17] Because patients with HF cannot readily increase their cardiac output during exercise to burn calories, surgical weight loss is indicated not only to improve their potential HT eligibility, but also to potentiate reverse cardiac modeling by modulating the enterocardiac axis.[18] Bariatric surgery is effective for losing weight, and laparoscopic bariatric surgery (including gastric banding, Roux-en-Y gastric bypass [RYGB], and sleeve gastrectomy) has been safe for patients who have severe cardiopulmonary morbidities.[19]

Choosing the appropriate bariatric surgical procedure is crucial in the cardiac patient with morbid obesity. Laparoscopic sleeve gastrectomy, which has gained popularity among bariatric surgeons, can effect a long-term weight-loss profile similar to that of RYGB, but with

TABLE III. Procedures, Perioperative Details, and Complications

Patient	Procedural Details	LVAD Team Availability	Operative Time (min)	Hospital Stay (d)	In-Hospital Complications
1	Optical trocar through peritoneum	In OR	60	8	Subdural hemorrhage (POD 3)
2	15-mm RUQ and 5-mm RUQ, SX, UML, and LUQ	In OR	125	4	None
3	Optical trocar through peritoneum	Standby	128	22	Intra-abdominal hematoma (POD 2)
4	Optical trocar through peritoneum	Standby	85	4	None

LUQ = left upper quadrant; LVAD = left ventricular assist device; OR = operating room; POD = postoperative day; RUQ = right upper quadrant; SX = subxiphoid; UML = upper midline

No patient needed a blood transfusion.

TABLE IV. Perioperative Antithrombotic Therapy

Patient	Preoperative Therapy	INR at Surgery	Postoperative Therapy
1	Warfarin 6 mg stopped 3 d before; aspirin 325 mg not stopped	1.3	Continuous heparin drip started after operation
2	Warfarin 3 mg stopped 3 d before; aspirin 325 mg stopped 5 d before	1.25	Preoperative regimen resumed after operation
3	Continuous heparin drip stopped 24 hr before; aspirin 81 mg not stopped	1.0	Heparin drip resumed after operation (stopped POD 1 because of hematoma)
4	Aspirin 325 mg and dipyridamole 75 mg stopped 10 d before	NA	Preoperative regimen resumed POD 1

INR = international normalized ratio; NA = not available; POD = postoperative day fewer nutritional complications and similar or lower risks of operative morbidity and death.[19] When patients need anticoagulation, as do most who have an LVAD, LSG is less likely than gastric bypass surgery to cause bleeding complications from marginal ulcerations. The absence of a permanent foreign body in LSG is also preferable, especially considering the chronic immunosuppression that patients need when bridged to transplantation.

Unlike RYGB, LSG is primarily a restrictive procedure that does not induce malabsorption of crucial medications such as posttransplant immunosuppressive agents. However, large fluctuations in weight may substantially affect anticoagulation status despite the bariatric surgical approach, and patients may need more frequent monitoring to ensure a proper therapeutic window.[20] Large changes in body habitus after bariatric surgery may also distort spatial relationships among the heart, the LVAD, and the cannulas; disrupted flow can result in thrombosis.[21] Although 2 of our 4 patients had LVAD thrombus that necessitated device exchange, both events occurred more than a year after LSG, and no mechanical disturbance had been noted at operation.

Patient 3 regained weight at 6 months, a phenomenon documented after bariatric surgery in general and specifically in case series of LSG in LVAD patients.[22,23] The typical approach in this circumstance is conversion to RYGB; however, whether this action is appropriate for patients who have LVADs is not clear.

The difficult removal of Patient 3's thoracoabdominal LVAD after LSG is noteworthy for surgeons who treat cardiac patients who are morbidly obese. Implanting an intrapericardial LVAD initially may be prudent in anticipation of future bariatric surgery. Although it is tempting to presume that an intrapericardial circuit would be less susceptible to mechanical distortion associated with dramatic body-habitus changes after bariatric surgery, this phenomenon has not been directly investigated.

In the largest series describing LSG's feasibility in patients with LVADs, Hawkins and colleagues[24] reported their experience with 11 patients (median follow-up time, 12 mo): 7 attained a target BMI <35, and 4 underwent HT. Similarly, Greene and associates[21] treated 3 patients who lost 81% excess weight on average and were listed for HT; 2 underwent it. Chaudhry and coauthors[23] compared 6 patients with advanced HF who underwent LSG (3 with LVADs and 3 without). Comparable long-term excess weight loss occurred in both groups (median follow-up time, 22 mo in the LVAD group), and 2 LVAD patients lost enough weight for HT. Wikiel and associates[25] compared 2 patients with LVADs who underwent RYGB with another 2 who underwent LSG. Both LSG patients and one RYGB patient lost enough weight for HT. In a unique series, Shah and colleagues[26] investigated concurrent LSG and LVAD placement in 4 patients with advanced HF, a combination treatment intended to avoid perioperative chronic anticoagulation management. One patient underwent HT after 9 months of LVAD support, another was listed, and none died or had major perioperative morbidity.

TABLE V. Patient Status 24 Months After Laparoscopic Sleeve Gastrectomy

Patient	NYHA Class	Transplant Status	% Excess BMI Lost at Maximal Weight Loss	Weight (kg)	Body Mass Index
1	II	Destination therapy	75.9	96.3	29.6
2	II	Listed (status 1B)	87.4	77.1	28.3
3	II	Destination therapy	38.7	120.1	50.3
4	I	Bridge to transplant	69.1	112.9	36.8

NYHA = New York Heart Association

TABLE VI. Listing Status for Heart Transplantation at Last Follow-Up

Patient	Follow-Up Time (mo)	NYHA Class	Latest BMI	Weight Change Since LSG (kg)	Transplant Status	Status Explanation
1	36	I	30.1	–34.9	DT	Substance abuse
2	47	I	28.3	–30.6	Listed (1B)	Listed
3	24	II	44.3	+5.6	BTT	BMI >35
4	47	I	37.1	–55.4	BTT	BMI >35

BMI = body mass index; BTT = bridge to transplantation; DT = destination therapy; LSG = laparoscopic sleeve gastrectomy; NYHA = New York Heart Association

Overall, LSG is tolerated and effective in patients on LVAD support, many of whom attain HT candidacy. Of note, none of the patients appeared to have experienced detrimental effects, and one was weaned from LVAD support after sufficient weight loss.[27] In addition, all had substantially improved NYHA functional status.

The results of our small study parallel those of previous small series during substantially longer follow-up times, showing that LSG did not impede ongoing LVAD management and resulted in durable functional improvement. Our patients chiefly had complications secondary to bleeding from anticoagulation, but no notable perioperative morbidity. One patient was listed for HT and the others remained stable on LVAD support after LSG. Of note, our patients underwent LSG at tertiary centers with LVAD teams present or on standby. We recommend performing LSG at centers that are equipped to treat high-risk cardiac patients, with access to HF teams and bariatric surgeons.

In patients with morbid obesity who receive LVAD support for end-stage HF, we found that LSG facilitated weight loss and improved symptoms to the point of candidacy for HT. Larger, multidisciplinary studies are warranted.

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