REVIEW ARTICLE

Bariatric surgery in transplant recipients: A narrative review

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Morbidity and mortality rates are increased due to obesity after organ transplantation; in this regards, bariatric surgery (BS) is believed to be an effective treatment for posttransplant obese patients. Nevertheless, some studies are doubtful in terms of the effectiveness of BS, the most suitable bariatric procedure, and management of immunosuppressant drugs in some kinds of organ transplants. We evaluated nonsurgical therapies, weight reduction, adjustment of immunosuppressants, comorbidities, and the recommended surgical procedures for posttransplant BS for different types of organ transplantations.

Key words: Bariatric surgery, gastric bypass, immunosuppression, organ transplant

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INTRODUCTION

The global prevalence of obesity has nearly tripled since 1975. The World Health Organization has reported that more than 1.9 billion adults are overweight and over 650 million are obese.[1] Moreover, weight gain after organ transplantation has been reported in several studies.[2-5] Factors such as improved appetite, a change in eating habits, a sedentary lifestyle, and immunosuppressant consumption can cause weight gain after transplantation.[3]

Obesity increases morbidity and mortality after organ transplantation because it increases complications that relate to delay of graft function, allograft loss, and increased transplant costs.[6-8] Comorbidities such as nonalcoholic steatohepatitis, diabetes Type 2, sleep apnea, and cardiomyopathy are increased because of obesity; they have adverse effects on posttransplant survival and outcomes.[9-12]

Meta-analyses have shown that bariatric surgery (BS) for obesity has provided superior results in comparison with nonsurgical treatments for control of comorbidities, weight loss, improved quality of life, and survival.[13,14] BS has been shown to be a valid treatment for obesity in posttransplant patients.[15] For different kinds of organ transplants, the efficiency of BS, the best technique, appropriate time for surgery, as well as management of immunosuppressant drugs must be addressed.[5,13,16] We evaluated these factors for posttransplant BS for different types of organ transplantations.

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METHODS

An online search of PubMed and Google Scholar was performed for identifying all relevant clinical literature on BS after transplantations using the following keywords: ("BS" OR "jejunoileal bypass" OR "gastric bypass" OR "obesity surgery" OR "vertical banded gastroplasty" OR "biliopancreatic diversion" OR "gastric banding" OR "Scopinaro" OR "intestinal bypass") AND ("transplant" OR "transplant recipient" OR "transplantation" OR "allograft" OR "immunosuppression"). The last search was done on April 1, 2018. We only used original articles with full texts in English covering case series, case reports, and clinical trials.

RESULTS

Obesity after transplantation

A cohort study was performed on 502 patients to investigate weight gain in patients who had undergone liver, heart, and lung transplants. They had experienced a decrease in body mass index (BMI) at 2 months after surgery, which was probably caused by a decrease in fluid retention. Following this weight loss, the BMI began to increase in all groups. At 12 months after surgery, the heart and lung transplant groups had significantly higher BMIs compared to before surgery ($P = 0.05$ and 0.006, respectively).[17]

A retrospective study on obese patients after renal transplants indicated that nine out of ten patients showed a 13% increase in body weight after transplantation. The median weight and BMI were 102 kg (84–142 kg) and 36 kg/m^2 (30–48 kg/m^2) at transplantation and 119 kg (96–152 kg) and 42 kg/m^2 (37–49 kg/m^2) before laparoscopic sleeve gastrectomy (LSG).[18]

Weight gain after heart transplant also has been reported in a 55-year-old male with a BMI of 29 kg/m^2 (weight 95 kg) at the time of transplant showed an increase in BMI of 46 kg/m^2 (weight 138 kg) at 6 years posttransplantation which can lead to lung function disturbance and diabetes mellitus.[19]

Nonsurgical approaches to obesity after transplantation

Effectiveness

Physical activity, behavioral treatment, diet, and drugs such as orlistat, phentermine-topiramate, and lorcaserin have been used as acceptable treatments for postliver-transplant obesity. However, their effectiveness is reported to be limited and more research is required to investigate approaches that are more effective.[20]

A study reported that 30% of obese candidates on a waiting list for transplants had a reduced BMI below 35 kg/m^2 at transplantation. The patients who had lost weight to be on the waiting list had the highest risk of quickly regaining weight in the early posttransplantation period without significant benefit for survival or graft outcomes.[21] In addition, Molnar *et al*. noted that obese patients who rapidly lost weight before a transplant regained the weight with insignificant long-term benefit.[22]

Risks

One important risk of pharmacological treatment of obesity after organ transplant is unknown interactions of those drugs (such as orlistat or lorcaserin) and immunosuppressive drugs.[20] In a comparative study of 22 morbidly obese patients who underwent BS and 44 obese patients on lifestyle management, all of whom underwent renal transplant surgery, Gheith *et al*. concluded that the number of patients with viral infections was significantly higher (viruria, viremia, and nephropathy: $P = 0.008$, 0.34, and 0.01, respectively) in the obese nonbariatric group because of the use of strong immunosuppressive agents. Moreover, they reported significantly delayed graft function in the control group ($P = 0.006$).[23]

Schold *et al*. showed that weight loss for the individual listed for a transplant did not directly influence posttransplant mortality or graft loss, but it was rapid weight gain or loss that was significantly associated with graft loss in the nonobese. The authors found a significantly increased risk for death among underweight and normal weight patients (adjusted hazard ratio [AHR] = 1.47, 95% confidence interval [CI] 1.39–1.56 and AHR = 1.13, 95% CI 1.09–1.18, respectively).[21]

Comparison with surgical approaches

Gheith *et al*. reported significant decreases in mean BMI in the BS group but not in the control group which was maintained on lifestyle management. The laboratory metabolic parameters revealed no significant differences between the groups.[23]

Bariatric surgery before, during, and after transplantation

Before transplantation

BS can be beneficial to patients awaiting liver transplantation (LT) and may improve obesity-associated problems before transplantation.[20,24] Reported benefits are an increased survival rate and decreased risk of perioperative complications after weight loss from BS. On the other hand, transplant programs may exclude obese candidates for transplants because of the mentioned increased risks.[20]

In a retrospective study conducted by Lin *et al*., twenty patients with end-stage liver disease and six patients with end-stage renal disease underwent LSG before transplantation. Twelve months after surgery, the mean percentage of excess body weight loss was calculated to be 50%. At 1 and 3 months postsurgery, these numbers were estimated to be 17% and 26%, respectively. About 23% of these patients had postoperative complications in

comparison with the general population rate of 1%–5%. Bleeding, staple line leak, infections, and kidney injury were the observed postoperative complications. Preoperative mortality was zero. The mean time between BS and LT was 16.6 months. All patients achieved their BMI goal in 1 year.[25]

In another study on seven patients with end-stage renal disease undergoing Roux-en-Y gastric bypass (RYGB), six patients with cirrhosis, and two patients with end-stage lung disease were candidates for pretransplant LSG. The mean percentages of excess body weight loss were 61%, 33%, and 61.5% in patients with end-stage renal disease, cirrhosis, and end-stage lung disease, respectively. About 93% of patients reached their BMI goal for transplantation. Comorbidities associated with obesity were ameliorated in all patients.[26] Despite this, a review by Dziodio suggested that BS before LT is associated with high morbidity and mortality. Dziodzio's study results showed that BS appeared to be harmless in the reported patient series and provided good weight loss before kidney transplant. Gastric bypass was related to a somewhat higher mortality and noticeably higher morbidity (12% vs. 2%) in comparison with sleeve gastrectomy. However, data from the review suggest that BS before LT is associated with high morbidity and mortality.[27]

Kumar *et al*. performed simultaneous living donor liver transplant and sleeve gastrectomy on an obese patient with non-alcoholic steatohepatitis related end-stage liver disease. The postoperative results showed a weight loss of 25%, controlled diabetes, improved mobility, and desirable graft function.[28] Safwan *et al*. reported on a retrospective series of 11 patients with a history of BS and histologic features of NASH. This confirms the feasibility of LT after BS, but if a RYGB has been performed, biliary reconstruction may be difficult, and hepaticojejunostomy is needed because a second Roux-en-Y loop should be fashioned.[29]

During transplantation

Simultaneous BS and transplantation decreases stress and pain, reduces costs, and decreases the hospitalization period.[24] Heimbach *et al*. compared weight loss in the noninvasive pre-transplant approach and simultaneous LT and sleeve gastrectomy. Seven of 44 patients underwent LT with sleeve gastrectomy. No post-LT diabetes and steatosis were seen in those patients. They reached a mean BMI of 29 without death or graft loss. One patient had excessive weight loss down to a BMI of 20. A leak from the gastric staple line was observed in one patient.[30]

After transplantation

Weight loss effects

The effect of BS on weight loss in transplant patients is summarized in Table 1. Studies have reported different effects of BS on weight loss. Lazzati *et al*. performed a systematic review on patients who underwent BS before, during, and after LT. They examined 11 studies with a total of 56 patients. The percentage excess weight loss (EWL) of 53.9% and a decrease in mean BMI from 46.8 to 33.5 kg/m^2 after 1 year of follow-up was reported. They concluded that, despite the higher mortality and morbidity, BS appears to be feasible in patients along with LT.[31] In a review by Tsamalaidze *et al*., the BMI for laparoscopic robotic-assisted RYGB decreased from 37.5 to 27.5 at 1-year postsurgery and in LSG patients decreased from 36.1 to 30 at 1-year postsurgery.[32] Dziodzio's review showed that the EWL for BS after kidney transplantation ranged from 31% to 61%. Overall, the EWL in studies about BS after ranged from 30% to 87%, with sleeve gastrectomy revealing the best weight loss and adjustable gastric banding being the least effective. The EWL from BS after LT ranged from 21% to 75%. The largest weight loss was in patients after sleeve gastrectomy (EWL: 54.9% vs. 37.9% after gastric bypass).[27]

The effects of sleeve gastrectomy on weight loss were evaluated in some studies. Butte reported a weight reduction of 28 kg (weight 88 kg; BMI 29.8 kg/m^2) after open sleeve gastrectomy.[33] Results of a clinical trial showed that sleeve gastrectomy decreased EWL to 55.5% at 6 months after the procedure and 70% after 2 years.[34] In a retrospectively observational descriptive study done by Osseis *et al*., surgical outcomes, kidney and liver tests, outcomes of obesity-related comorbidities, and EWL were put to analysis on six patients undergoing sleeve gastrectomy after LT. The median EWL was 76% after 2 years.[35]

Follow-ups of seven obese renal transplant patients revealed that the median weight and BMI decreased from 119 kg (96–152) and 42 kg/m^2 (37–49) to 93 kg and 33 kg/m^2, 86 kg and 31 kg/m^2, and 83 kg and 29 kg/m^2 at 3, 6, and 12 months post-LSG. The median EWL was 54% at 3 months, 57% at 6 months, and 75% after 1 year.[18] Another study of LSG showed that it produced a mean decrease in BMI of 12.9 kg/m^2 in 12 patients after orthotopic liver transplant (OLT). This decrease in BMI was 9.17 kg/m^2 in the non-OLT control group. However, the study revealed that the EBWL of non-OLT patients showed more weight loss than for the OLT group ($P < 0.001$).[36] Szomstein *et al*. showed a series of five recipients, including four who underwent laparoscopic RYGB and one with LSG. All patients in this series achieved >50% EBWL after 2 years with a change in BMI of −13.6–−37 kg/m^2.[37]

Al-Nowaylati *et al*. assessed the outcomes of RYGB in a case series of seven patients undergoing RYGB after OLT. Therapeutic weight loss (mean BMI of 44.34 ± 6.08 kg/m^2 before RYGB and 26.47 ± 5.53 kg/m^2 after RYGB) was reported after RYGB.[38]

Table 1: Summary of the published studies of bariatric surgery in transplant patients

Organ transplanted	Study (first author, year of publication, and reference)	Type of bariatric surgery	Patients (*n*)	Mean/median period between transplantation and bariatric surgery	Effect on weight	Comorbidities
Liver	Tichansky 2005[43]	RYGB	1 (A 49-year-old women)	2 years	Decreased BMI from 54 to 43 kg/m^2	Arthritis, DM, HTN, hyperlipidemia, GERD, depression, and a history of a previous orthotopic liver transplant for hepatitis C induced cirrhosis
	Butte 2007[33]	Open sleeve gastrectomy (combined with Roux-en-Y biliary reconstruction)	1	2 months	Decreased BMI from 47 to 29.8 kg/m^2	DM and arterial HTN
	Al-Nowaylati 2013[38]	RYGB	7	26.57±8.64 years	Decreased BMI from 44.34±6.08 kg/m^2 to 26.47±5.53 kg/m^2	DM, HTN, hyperlipidemia, GERD, vascular disease, and OSA
	Lin 2013[34]	Sleeve gastrectomy	9	5.9±2.4 years	Decreased % EWL of 55.5% at 6 months and 70% at 2 years	Not mentioned
	Tariciotti 2016[44]	Sleeve gastrectomy	1 (A 53-year-old woman)	5 months	Decreased BMI from 40 to 29 kg/m^2	Hepatocellular carcinoma and HCV related, cirrhosis, and morbid obesity
	Tsamalaidze 2018[36]	LSG	12	63.1±33.2 months	Mean BMI decrease of 12.9 kg/m^2	Nine of 12 had metabolic syndrome and DM due to liver transplant and immunosuppressive therapy, which was resolved in four of them after LSG
	Osseis 2018[35]	Sleeve gastrectomy	6	Median: 44 months (Range: 36-46.7 months)	Median % EWL and BMI of 76% (Range: 25%-119%) and 29 kg/m^2 (Range: 21-39 kg/m^2) at 1 year	DM, HTN, OSA, dyslipidemia, and hypothyroidism
	Safwan 2017[29]	RYGB, sleeve gastrectomy, and jejunoileal bypass	11	11.6±11 years	Mean BMI of 28.3±5.8, 28.0±3.2, and 31.0±6.6 kg/m^2 at 1, 6, and 12 months postliver transplant	Not mentioned
Liver and kidney	Lin 2013[34]	Sleeve gastrectomy	9	16.6±14 months	61.5% loss of EWL	Mesh dehiscence after synchronous incisional hernia repair, bile leak, postoperative dysphagia
Kidney	Szomstein 2010[37]	RYGB and sleeve gastrectomy	5	Not mentioned	Percentage EWL of over 50% at 2 years for all of patients	DM, HTN, hyperlipidemia, polycystic ovarian syndrome, peripheral vascular disease, and CHF
	Arias 2010[41]	Gastric bypass	5	Ranged between 18 and 48 months	Mean weight loss of-33.4 kg	DM, HTN, and hyperlipidemia
	Golomb 2014[18]	LSG	10	Median: 6 years (Range: 0.4-8 years)	Median % EWL of 54% at 3 months, 57% at 6 months, and 75% 1 year	Not mentioned
	Gazzetta 2017[42]	Sleeve gastrectomy	6	Median: 91 months (Range: 31-131 months)	Mean % EWL of 27.6% at 1 month, 44.1% at 3 months, 74.2% at 6 months, and 75.9% at 12 months	Morbid obesity
Heart and kidney	Rex 1991[39]	Vertical banded gastroplasty	2	Both 2 years	Loss of 56 kg (from 136 to 80 kg) for heart transplant patient and 54 kg (from 133 to 82 kg) for the kidney transplant patient	Not mentioned

Contd..

Table 1: Contd..

Organ transplanted	Study (first author, year of publication, and reference)	Type of bariatric surgery	Patients (*n*)	Mean/median period between transplantation and bariatric surgery	Effect on weight	Comorbidities
Heart	Ablassmaier 2002[19]	LAGB	1 (A 55-year-old man)	Not mentioned	Decreased BMI from 46 to 35.4 kg/m^2	Not mentioned
	Tsamalaidze 2017[32]	RYGB and sleeve gastrectomy	2	7 years and 2 years	Decreased BMI from 37.5 to 27.5 kg/m^2 1 year after surgery for laparoscopic robotic-assisted RYGB, and from 36.1 to 30 kg/m^2 1 year after surgery for LSG	HTN, hyperlipidemia, anemia, and hypomagnesaemia
LVAD	Greene 2017[40]	Sleeve gastrectomy	3	Not mentioned	Average % EWL of 81% (Range: 75%-92%)	HTN, HF, and anemia

LVAD=Left ventricular assist device; RYGB=Roux-en-Y gastric bypass; BMI=Body mass index; DM=Diabetes mellitus; HTN=Hypertension; GERD=Gastroesophageal reflux; OSA=Obstructive sleep apnea; EWL=Excess weight loss; LSG=Laparoscopic sleeve gastrectomy; CHF=Chronic heart failure; LAGB=Laparoscopic adjustable gastric banding; HCV=Hepatitis C virus

In heart transplant patients, laparoscopic adjustable gastric banding in combination with laparoscopic cholecystectomy led to a decrease in patient BMI from 46 kg/m^2 (138 kg) to 35.4 kg/m^2 (106 kg) after 28 months.[19] Rex reported that a heart transplant patient lost 56 kg (136 to 80 kg) and a kidney transplant patient lost 54 kg (133 to 82 kg) after vertical banded gastroplasty.[39]

Greene achieved an average decrease in BMI of 19 (range: 16–22) per patient, to reach an average BMI of 30 (range 26–32). The group had an average 39% TWL (range 37%–41%) and an average 81% EWL (range 75%–92%).[40] Arias *et al*. showed five recipients with laparoscopic gastric bypass with a mean weight loss of 33.4 kg. Interestingly, these patients had gained an average weight of 16.75 kg after kidney transplantation.[41] Gazzetta *et al*. performed retrospective research on six patients undergoing BS after renal transplant. The mean EWL was 75.9% after 12 months. No main weight regain was observed.[42]

Effects on transplanted organ

An improvement in graft function has been reported in a systematic review of bariatric patients following LT.[31] Important factors influencing the long-term survival of a transplanted organ are dependent on cardiovascular factors and blood flow. BS successfully decreased these risk factors.[15] Golomb *et al*. reported that 24-h proteinuria and serum creatinine decreased after LSG for ten obese renal transplant patients, and this is a positive prognostic marker. The protein concentration in the urine decreased from a median of 391 mg/24 h to 207 mg/24 h.[18] Lin reported no incidents of graft rejection; also they showed that at 3 months after surgery, liver function tests continued to be stable.[34] Tsamalaidze reported no effects on the transplanted organ.[32]

Dziodzio's review reported that three out of four studies containing twenty patients observed improvement in graft function after kidney transplant. One kidney graft loss after gastric bypass was reported. Stable graft functions and unaltered immunosuppression regimens were observed in LT. Two case series have reported biopsy-proven regression of steatosis after gastric bypass.[27]

Butte reported normal liver function tests and stable trough levels of cyclosporine.[33] Tariciotti *et al*. reported on the first European combined LT and sleeve gastrectomy. The patient was a 53-year-old female with hepatocellular carcinoma, morbid obesity (BMI 40 kg/m^2), and Type 2 diabetes. Five months after surgery, she had normal allograft function.[44] Osseis *et al*. reported that liver graft function was retained or enhanced in all patients.[35]

Dose adjustment of immunosuppressive drugs

Table 2 lists studies and changes in doses of immunosuppressive drugs. Most of the studies reported

no change in immunosuppressive drugs dose, which is considered necessary after BS. However, studies that checked serum level of the drugs reported the need to either increase or decrease the dose of the drugs.

Risks

Table 3 lists reports complications of BS in transplant patients. There was no mortality report in reviewed studies; but there were complications including gastric leak, bile leak, reflux, and infectious complications due to BS. There were also concerns about the effects of BS on absorption of immunosuppressive drugs.

Comorbidities

Table 1 summarizes a wide spectrum of comorbidities of bariatric patients who underwent organ transplant. Obesity-related comorbidities including diabetes mellitus, hypertension, hyper/dyslipidemia, obstructive sleep apnea, and metabolic syndrome

Table 2: Dose adjustment of immunosuppressants following bariatric surgery in transplant patients

Organ transplanted	Study (first author, year of publication, reference)	Type of bariatric surgery	Number of patients	Immunosuppressive drug adjustment
Liver	Lin 2013[25]	Sleeve gastrectomy	9	No change
	Lazzati 2015[31]	Not mentioned	56	No change
	Tsamalaidze 2018[36]	LSG	12	No significant change
Kidney	Deogracias 2007[45]	Biliopancreatic diversion	1	No change
	Rogers 2008[46]	Gastric bypass surgery	2	Increased dose for sirolimus, tacrolimus, and mycophenolate mofetil
	Szomstein 2010[37]	Laparoscopic surgery	5	Decreased dose of cyclosporine
	Arias 2010[41]	Laparoscopic gastric bypass	5	No change
	Golomb 2014[18]	Sleeve gastrectomy	10	Two increased dose of tacrolimus and one decreased (based on serum level)
	Gazzetta 2017[42]	Sleeve gastrectomy	6	No change
Heart and kidney	Rex 1991[39]	Vertical banded gastroplasty	1	Changes based on serum level
Heart	Ablassmaier 2002[19]	Laparoscopic gastric banding	1	No change
	Tsamalaidze 2017[32]	Laparoscopic robotic-assisted RYGB, and LSG	2	No change

LSG=Laparoscopic sleeve gastrectomy; RYGB=Roux-en-Y gastric bypass

Table 3: Complications of bariatric surgery in transplant patients

Organ transplanted	Study (first author, year of publication, and reference)	Type of bariatric surgery	Number of patients	Risks after transplantation
Liver	Heimbach 2013[30]	Sleeve gastrectomy	7	Gastric staple line leak, EWL
	Lin 2013[25]	Sleeve gastrectomy	9	Superficial wound infections, staple line leak, postoperative bleed requiring blood transfusion, transient encephalopathy, and temporary renal insufficiency
	Lin 2013[34]	Sleeve gastrectomy	9	Mesh dehiscence after a synchronous incisional hernia repair, bile leak from the liver surface requiring laparoscopic drainage, and postoperative dysphagia that required reoperation
	Ayloo 2015[20]	Not mentioned	Narrative review	Elevate risk of anastomotic or staple lines dehiscence or wound complications in bariatric surgery because of steroid therapy
	Tsamalaidze 2018[36]	LSG	12	Risk of complications (infections and leaks) due to immunosuppressive therapies. May potentially alter the absorption of the immunosuppressive medications
Liver and kidney	Dziodzio 2017[27]	Not mentioned	Narrative review	Bile leakage, early reoperation due to dysphagia, and bleeding
Kidney	Modanlou 2009[47]	Not mentioned	188	Cardiac and infectious complications
	Golomb 2014[18]	Sleeve gastrectomy	10	Acute renal failure and sleeve stricture
Heart and kidney	Rex 1991[39]	Vertical banded gastroplasty	1	Inadvertent laceration of the body of the pancreas during the dissection of dense retro gastric adhesions. Subsequently, developed a pancreatic pseudocyst which required percutaneous and then surgical drainage
LVAD	Greene 2017[40]	Sleeve gastrectomy	3	Reflux>30 days (so endoscopic balloon dilatation of a midsleeve was performed)

EWL=Excess weight loss; LSG=Laparoscopic sleeve gastrectomy; LVAD=Left ventricular assist device

were considered resolved following BS. A study of 12 patients revealed that nine had metabolic syndrome and diabetes mellitus after OLT caused by obesity and immunosuppressant drugs. Of them, four had completely regressed after LSG.[36] Tichansky *et al*. presented a case study on a 49-year-old woman who was referred for evaluation as a candidate for BS. The patient had complete resolution of her hypertension and diabetes.[43]

Type of bariatric surgery

Table 1 summarizes the types of BS used in various studies. In older studies, gastric banding was used most. Recently, its use has decreased due to foreign-body complications. Other methods used are RYGB, laparoscopic, and open sleeve gastrectomy. Few studies have compared outcome and complications of the different BS methods for organ transplant patients. Table 4 outlined bariatric surgery among different organ recipients.

DISCUSSION

Sleeve gastrectomy is a feasible option for liver recipients since it facilities endoscopic access to the bile duct and duodenum; this is a significant event because 12%–30% of LT patients will need future endoscopic technique associated with their transplanted liver.[48] After effective LT, patients with obesity have a high risk of weight regain. Minor global experience with bariatric operations after LT shows good weight control after bariatric operation. However, several issues regarding gastric bypass after LT must be considered.

Gastric bypass excludes the possibility of simple retrograde access to the biliary tree in a patient cohort, which would be mandatory in near 30% of liver transplants patients.[49] Further concerns have been voiced regarding the kinetics of enteral absorption and metabolism of immunosuppressive agents after a hypoabsorptive surgery. Unlike this assumptive theory, no significant effects on immunosuppression absorption were observed, and most reports disproved this challenge.[38] The extent of dissection after LT required for gastric bypass results is higher operative difficulties for LT patients compared to a sleeve gastrectomy, but this does not seem to mean a higher complication rate in the reported patient series. Based on published papers, we propose that BS should be

Table 4: Effect of bariatric surgery on transplanted organ

Organ transplanted	Study (first author, year of publication, reference)	Type of bariatric surgery	Number of patients	Evaluation method	Effects on transplanted organ
Liver	Duchini 2001[3]	RYGB	2	Liver biopsy	Reduced liver steatosis, absence of fibrosis and minimal portal inflammation
	Al-Nowaylati 2013[38]	RYGB	7	Liver function test and albumin	The albumin level decreased in the patients who died in the post-RYGB period; however, the mean albumin level improved for the surviving patients. The mean AST, ALT, and total bilirubin levels declined postoperatively
	Lin 2013[25]	Sleeve gastrectomy	9	Liver function test	No episodes of graft rejection. At 3 months liver function tests remained stable
	Butte 2007[33]	Open sleeve gastrectomy (combined with Roux-en-Y biliary reconstruction)	1	Liver function test	Normal liver function test
	Taricciotti 2016[44]	Sleeve gastrectomy (combined with liver transplant)	1	Liver function test	Liver function test was normal 6 months after surgery, nondetectable HCV RNA level
	Osseis 2018[35]	Sleeve gastrectomy	6	Liver function test	Liver function tests values at last follow-up were not significantly different as compared to values before sleeve gastrectomy (paired *t*-test $P>0.05$)
Kidney	Golomb 2014[18]	Sleeve gasterectomy	10	24 h proteinuria and serum creatinine	Proteinuria decreased from median of 391 mg/24 h to 207 mg/24 h ($P=0.05$) The median creatinine level decreased from a median 1.44 mg/dL (0.78-1.88) before the operation to 1.25 mg/dL, 12 months after operation ($P=0.04$)
	Dziodzio 2017[27]	Not mentioned	20	Not mentioned	Three out of four studies reported improvement in graft function in kidney transplant. One kidney graft loss after gastric bypass was reported
Heart	Tsamalaidze 2017[32]	Laparoscopic robotic-assisted RYGB, and LSG	2	Trans esophageal echocardiography	No effect on transplanted organ No signs of rejection

RYGB=Roux-en-Y gastric bypass; ALT=Alanine aminotransferase; AST=Aspartate aminotransferase; HCV=Hepatitis C virus; LSG=Laparoscopic sleeve gastrectomy

recommended only after exhaustion of all nonoperative therapies and recovery from LT. If performed in these patients, sleeve gastrectomy should be reserved as first option.[27]

After LT, the sleeve gastrectomy was selected as a weight-decreasing technique for a patient by the bariatric team because of its restrictive and nonmalabsorptive nature. This is pertinent given the potential interference of a malabsorptive technique such as RYGB with the absorption of immunosuppressive drugs. Actually, the cyclosporine dosage did not have to be adjusted in one patient for stable blood serum levels of the drug; consequently, this operation seemingly is an interesting option for obese patients after LT.[33]

For kidney transplants, the data suggest that BS is a logic, easy, and safe option for to treat morbidly obese end-stage renal disease patients and kidney transplant recipients, irrespective of the timing associated with the organ transplantation. In addition to the less effective adjustable gastric banding, all studies revealed weight loss similar to the nontransplant population. Regrettably, mid- and long-term follow-ups were only outlined by five surveys. Contrary to kidney transplant waiting list patients (sleeve gastrectomy), gastric bypass was the favored technique after kidney transplant (79%). This may be explained by the enhanced health of kidney transplant patients in comparison with the waiting list population and the inclination of surgeons to perform a more intricate technique in a stable patient setting. Patients undergoing gastric bypass revealed distinctly lower major complication rates after than before kidney transplant (1.1% vs. 12%). The postkidney transplant complication rates were similar to the nontransplant population. The general reported 30-day mortality rate was low (0.8%), though, the 1-year mortality of BS of 3.9% before kidney transplant and 2.5% after kidney transplant was above the rates of the nontransplant setting (<1%). In contrast, the average 1-year mortality on the waiting list is 7% reaching 3% after kidney transplant. After kidney transplant, the link between obesity and mortality is not clear and most authors did not report any apparent link.[27] According to the case reports reviewed, switching from sleeve gastrectomy to BS for gaining weight loss in renal transplant patients is safe and achievable.[23,50] The main limitation in our review was the sample size. The number of papers focusing on BS among transplant surgery is lacking. The diversity of presented data is wide. Therefore, more studies need in this topic.

CONCLUSION

Nonsurgical therapies for transplanted morbid obese patients showed poor results for weight loss. Weight loss after BS in posttransplant patients is significant and similar to the normal people. Contrary to sleeve gastrectomy, following gastric bypass, dose adjustment of immunosuppressant agents is essential. Improved comorbidities such as diabetes mellitus, sleep apnea, NASH, and cardiac problems after weight loss operations are satisfactory and similar with normal population. Operative-related complications such as liver injury, fistula, infection, and anastomosis leak seem a little higher than other patients. Sleeve gastrectomy is suggested as the procedure of choice for posttransplant patients, but gastric bypass has been considered a satisfactory option with good outcomes. Procedures such as LAGB lead to more complications and are not recommended.

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Conflicts of interest

There are no conflicts of interest.

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