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ORIGINAL CONTRIBUTIONS

Effectiveness of Bariatric Surgery in Increasing Kidney Transplant Eligibility in Patients with Kidney Failure Requiring Dialysis

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Abstract

Purpose Severe obesity can increase risk of complications after kidney transplantation. There is a paucity of literature on bariatric surgery outcomes in renal transplant candidates. The objective of this study was to analyze outcomes of bariatric surgery as a weight reduction strategy for patients with kidney failure to enhance eligibility for kidney transplantation.

Materials and Methods We performed a retrospective analysis of the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program database at a single institution for patients with chronic kidney disease receiving hemodialysis therapy (CKD G5D) undergoing bariatric surgery between 2011 and 2018.

Results Of 2363 patients who underwent bariatric surgery, 38 (1.6%) had CKD G5D; median age (range) was 49 years (33; 69), 52.6% were female, and mean BMI was 44.2 kg/m^2. Twenty-four patients underwent laparoscopic Roux-en-Y gastric bypass (LRYGB), and 14 patients underwent laparoscopic sleeve gastrectomy. Seventeen patients (46%, n=37) had a BMI≤35 at 6 months, while 25 patients (75.8%, n=33) achieved a BMI≤35 at 12 months. Of these, 18 patients (47%) were listed for kidney transplant, and 8 patients (21%) received kidney transplant. There was no statistically significant difference between sleeve and LRYGB procedures in patients who reached BMI of 35 at 12 months (P=0.58). Median length of stay was 2.3 days. Thirty-day readmission rate was 2 patients (5.3%), and 2 patients (5.3%) required reoperation (one for bleeding, one for acute recurrent hiatal hernia). No mortality occurred.

Conclusion Laparoscopic bariatric surgery offers effective weight loss for CKD G5D patients to achieve transplant eligibility with acceptable outcomes.

Keywords Kidney transplantation · Hemodialysis · Bariatric surgery · Gastric bypass · Laparoscopic sleeve gastrectomy

Key Points
• Predominantly gastric bypass patients as opposed to sleeve gastrectomy most other ESRD studies.
• Around 76% of patients achieved transplant weight eligibilty by 12 months.
• Almost half were listed and 21% received kindney transplantation even in the limited follow up time..

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Introduction

Kidney transplantation has been identified as the treatment of choice for patients with kidney failure, by extending length and improving quality of life [1–3], as well as resulting in lower hospitalization rates [3] and significant long-term cost savings to health systems compared to dialysis [3, 4]. In 2019, almost 23,401 kidney transplants were performed in the USA. However, the number of patients on the kidney transplant waiting list remains the largest among all patients requiring transplantation [5]. The well-documented rise in obesity among the adult population in the USA is also reflected in patients with kidney failure [6, 7]. In 2020, the reported proportion of hemodialysis patients undergoing evaluation for kidney transplantation with BMI >35 is 14.1% [8]. Therefore, there is a dire need to address the issue of obesity in patients who are being evaluated for kidney transplant to enhance their eligibility.

Obesity is linked to inferior transplant outcomes and carries a higher risk with kidney transplantation [9]. The risks associated with obesity in kidney transplant include longer operative times, more intraoperative blood loss, higher rate of surgical complications, increased surgical infections, and prolonged length of stay [9]. Additionally, kidney transplantation in patients suffering from obesity is associated with increased risk of delayed graft function, increased risk of acute rejection, and reduced graft survival [10]. Furthermore, the survival benefit of kidney transplantation for patients with BMI >40 kg/m^2 is significantly lower. A study has demonstrated that mortality in patients suffering from obesity undergoing transplantation is reduced by 50% compared to mortality in patients suffering from obesity remaining on dialysis, though this benefit was lost when BMI was higher than 40 kg/m^2 [11]. Therefore, extreme obesity (BMI ≥40 kg/m^2) is a relative contraindication to kidney transplantation, [12] and most US transplant centers use BMI of 35 kg/m^2 as a cut-off for kidney transplantation [13].

As access to kidney transplantation is often limited for patients with obesity and chronic kidney disease on dialysis (CKD G5D), weight loss through bariatric surgery has been suggested as a strategy to enhance access to transplantation [7, 14]. Bariatric surgery in kidney transplant patients is associated with improved similar maintenance of weight loss and improved long-term allograft survival compared to matched controls, regardless of whether bariatric surgery is performed pre- or post-transplantation [12].

The aim of our study is to investigate the effectiveness of bariatric surgery as a weight reduction strategy in CKD G5D patients whose BMI posed a barrier to kidney transplantation eligibility.

Patients and Methods

With approval by the Houston Methodist Research Institute Institutional Review Board, a retrospective analysis was conducted of the prospectively collected Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) database at our institution of patients with CKD G5D who underwent bariatric surgery between January 2011 and December 2018. Prior to bariatric surgery, these patients were deemed ineligible for kidney transplantation because their BMI exceeded the institutional recommendation of 35 kg/m^2. For this patient cohort, conservative measures (like exercise and diet restrictions) were unsuccessful at achieving their target BMI required for transplantation.

The retrieved data captured patient demographics (age, race/ethnicity, gender, height, and weight at different follow-up periods), comorbidities, perioperative complications, transfusions, readmissions, functional health status (independent vs. dependent), and mortality. The decision to undergo the chosen bariatric procedure (laparoscopic Roux-en-Y gastric bypass (LRYGB) vs. laparoscopic sleeve gastrectomy (LSG)) was based on the usual criteria in any bariatric patient: a combination of associated comorbidities, physician recommendation, and patient preference. All patients received hemodialysis the day before surgery and resumed their scheduled dialysis post-operative day 1 with less aggressive removal of fluids after communication with their nephrologists.

LRYGB and LSG were performed using a standard approach at our center. After general anesthesia was induced, 4 trocars and Nathanson liver retractor were inserted into the abdomen. For LRYGB, an antecolic, antegastric LRYGB was performed with biliopancreatic limb length of 30 cm from the ligament of Treitz and a Roux limb length based on BMI with a 125-cm Roux limb for patients with BMI < 50 and 150 cm for patients with BMI > 50. A small lesser curvature-based gastric pouch was created at the left gastric artery level. For LSG, a 40 French blunt tip bougie was introduced along the lesser curve toward the antrum, and the stomach was stapled using black and purple loads or green and blue loads depending on surgeon preference. Finally, the staple lines were over-sewn using absorbable sutures.

All patients were started on full-liquid diets on the day of surgery including their home medications (pills and tablets), and their diet was slowly advanced to a regular diet over the course of a month. Patients were followed routinely at the clinic at 1 week, 1 month, 3 months, 6 months, 12 months, 18 months, 24 months, and yearly thereafter.

Demographic and clinical data were reported as frequencies and proportions for categorical variables and as median and interquartile range (IQR) or mean (± standard deviation, SD) for continuous variables as appropriate. Differences between groups were compared using the Chi-square or Fisher's exact tests for categorical variables and unpaired *t*-test, ANOVA, or Wilcoxon rank-sum test for continuous variables, as appropriate.

Univariate and multiple regression modeling was performed to determine the characteristics associated with the outcomes. Specifically, robust Poisson regression models with a robust error variance were used to estimate the risk ratios and 95% confidence intervals. Variables having a *P*-value <0.2 in the univariate analysis or considered clinically significant were investigated further by multiple Poisson regression modeling. The likelihood-ratio test was used to reduce the model subsets. The best model was selected based on the smallest Bayesian information criterion (BIC). The area under the receiver operating characteristic (ROC) curve (AUC) determined the model discrimination. Model calibration was assessed using the Hosmer-Lemeshow goodness-of-fit test with a non-significant *P*-value indicating good calibration. All of the analyses were performed using Stata MP version 16.0 (Stata Corp LLC, College Station, TX, USA). A *P*-value <0.05 was considered statistically significant.

Results

Patient Characteristics

Of a total of 2363 patients having bariatric surgery, 38 (1.6%) had CKD G5D; of these 24 (63.2%) patients underwent LRYGB, while 14 (36.8%) underwent LSG for the treatment of sever obesity. Three patients in each group were revisions of adjustable gastric band to the respective procedures. More females (*n*=20, 52.6%) than males (*n*=18, 47.4%) made up the analytic group (Table 1). At the time of surgery, the median age was 49 years (range, 33–69). At baseline, the patients had a mean BMI of 44.5 ± 6 (range, 34–57.0) and were considered appropriate candidates for kidney transplantation except for their weight. They underwent bariatric surgery as a weight reduction approach to be eligible for kidney transplantation evaluation. The median length of hospital stay was 2.3 days (IQR, 1, 6). All patients were functionally independent at the time of surgery except one partially dependent patient due to peripheral arterial disease with below-knee amputation. Comorbidities at time of operation included hypertension in 25 patients (65.8%), diabetes in 20 patients (52.6%), hyperlipidemia in 17 patients (44.7%), gastroesophageal reflux disease (GERD) in 16 patients (42.1%), sleep apnea in 9 patients (23.7%), myocardial infarction (MI) in 7 patients (18.4%), pseudotumor cerebri in 3 patients (7.9%), and deep vein thrombosis (DVT) in 1 patient (2.63%). Moreover, 32 patients (84.2%) had two or more comorbidities including DM/HTN implicated in their CKD diagnosis. Finally, 2 patients (5.3%) had a previous organ transplant, while 5 patients (13.2%) were on therapeutic anticoagulation (Table 1).

Table 1 Demographic characteristics of ESRD patients undergoing bariatric surgery

Characteristic	*n*
Median age, years (range)	49 (33; 69)
Median BMI at baseline (range)	44.5 (33.4; 57.0)
Median length of stay, days (IQR)	2.3 (1, 6)
Race	
Black or African American	19 (50.0%)
White	16 (42.1%)
Asian	1 (2.6%)
Unknown	2 (5.3%)
Gender	
Male	18 (47.4%)
Female	20 (52.6%)
Type of bariatric intervention	
LRYGB	24 (63.2%)
Sleeve	14 (36.8%)
Comorbidities	
Hypertension	25 (65.8%)
Diabetes	20 (52.6%)
Hyperlipidemia	17 (44.7%)
SLE	4 (10.5%)
DVT	1 (2.6%)
PTC	3 (7.9%)
MI	7 (18.4%)
GERD	16 (42.1%)
Sleep apnea	9 (23.7%)
Number of comorbidities	
2 or fewer	6 (15.8%)
3–4	25 (65.8%)
5–6	7 (18.4%)
Medical history	
Therapeutic anticoagulation	5 (13.2%)
Previous organ transplant	2 (5.6%)

DVT deep vein thrombosis, *SLE* systemic lupus erythematosus, *GERD* gastroesophageal reflux disease, *LRYGB* laparoscopic Roux-en-Y gastric bypass, *MI* myocardial infarction, *PTC* pseudotumor cerebri

Outcomes of Bariatric Surgery

Patients experienced no intraoperative complications, though two patients (5.3%) were readmitted within 30 days of the index bariatric surgery; one of these cases presented with acute abdominal pain and was found to have an acute recurrent hiatal hernia with kinked gastric sleeve in the chest, while the other patient had contracted Clostridium difficile colitis accompanied with nausea/vomiting (Table 2). Two patients (5.3%) received blood transfusions as a result of intraabdominal bleeding in the immediate post-operative period while in the hospital; one was managed non-operatively, and the other returned to the

Table 2 Post-surgery outcomes of ESRD patients undergoing bariatric surgery (*N*=38)

Characteristic	*n* (%)
Intraoperative complications	0 (0)
Readmissions within 30 days	2 (5.3)
Recurrent hiatal hernia with abdominal pain	1 (2.6)
C diff colitis	1 (2.6)
Blood transfusions, intraabdominal bleeding	2 (5.3)
Reoperations within 30 days	2 (5.3)
Post-surgery death	0 (0)
Patients waitlisted	18 (47)
Patients transplanted	8 (21)

operating room and underwent diagnostic laparoscopy. A total of two reoperations were required within 30 days from the index surgery—the readmitted patient with recurrent hiatal hernia and one of the patients who had intraabdominal bleeding. No deaths occurred.

At 6-month post-surgery, out of the 36 patients with follow-up data, 15 (41.7%) patients had achieved the target BMI of ≤35 kg/m^2. At 12-month post-surgery, we had follow-up data on 29 patients, out of which 20 (69%) had achieved the target BMI. A follow-up of 24 months was available for 18 patients, for whom 12 (66.7%) continued to maintain a target BMI of ≤35 kg/m^2 (Table 3).

The mean (SD) BMI difference at 6-month post-surgery was found to be a weight loss of 7.33 kg/m^2 (3.73 kg/m^2), which further improved to 10.7 (5.5) kg/m^2 weight lost after 1 year. The mean weight loss difference at 6 months was 47.2 (24.1) lbs. At 1-year post-surgery, the mean weight loss difference increased to 68.5 (35.7) lbs. Mean total weight loss percentage at 6-month post-surgery was 16.5% (7.5%) and increased to 23.3% (10.4%) after 12 months. Finally, the post-surgery excess weight loss was found to be 40.1% (20.5%) 6 months after surgery, increasing to 53.9% (23.4%) 1-year post-surgery (Table 3).

Of the 29 patients with 12-month follow-up data, the BMI of 16 patients with baseline ≤45 kg/m^2 decreased to 31.87 (3.49) kg/m^2 at 12 months; BMI in 13 patients whose baseline was >45 kg/m^2 decreased to 36.47 (4.26) kg/m^2 at 12-month follow-up. BMI in 23 patients with baseline ≤50 kg/m^2 decreased to 33.6 (4.6) kg/m^2 at 12 months; BMI in 6 patients with baseline >50 kg/m^2 decreased to 35.3 (3.8) kg/m^2 at 12-month follow-up.

No statistically significant relationship was noted between procedure type (LRYGB vs LSG) and BMI ≤35 kg/m^2 at 12 months (P=0.94) (Table 4). There was also no statistically significant relationship between gender and BMI ≤35 kg/m^2 at 12 months (P=0.55). However, patients with BMI ≤45 at baseline were statistically more likely to have a 12-month BMI ≤35 than patients whose baseline BMI was ≥45 (P=0.001).

In a univariate model to examine the independent association between independent variables (patient demographics (age, race/ethnicity, gender, baseline BMI ≤45 kg/m^2, baseline BMI ≤50 kg/m^2) and comorbidities) and having a BMI ≤35 kg/m^2 at 12 months, patients with a baseline BMI ≤45 kg/m^2 were 2.4 times significantly more likely to have a BMI ≤35 kg/ m^2 at 12 months with a relative risk (RR) (95% CI) of 2.44 (1.20, 4.97), P=0.014 (Table 5). In addition, patients who were on therapeutic anticoagulation, when compared to those who were not, were 1.6 times significantly more likely to have a BMI ≤35 kg/m^2 at 12 months (RR [95% CI] = 1.56 [1.16, 2.11], P=0.003). However, in a multivariate model, after adjusting for other covariates (gender, age, race, and procedure type), those patients with a baseline BMI ≤45 kg/m^2, when compared to those with a baseline BMI >45 kg/m^2,

Table 3 Biometrics of ESRD population undergoing bariatric surgery

6-month follow-up, n	Population (of denominator N = 36)
BMI ≤35kg/m^2, n, mean (SD)	15, 31.79 (3.16)
BMI >35kg/m^2, n, mean (SD)	21, 40.28 (3.80)
BMI difference (kg/m^2), mean (range)	7.33 ± 3.73 (0.43; 20.22)
Weight difference (lbs), mean (range)	−47.2 ± 24.13 (−133; −3)
Total weight loss (%), mean (range)	16.46 ± 7.51 (1.17; 35.47)
Excess weight loss (%), mean (range)	40.09 ± 20.48 (3.67; 94.88)
12-month follow-up, n	Population (of denominator N = 29)
BMI ≤35 kg/m^2, n, mean (SD)	20, 31.58 (2.71)
BMI >35 kg/m^2, n, mean (SD)	9, 39.16 (2.63)
BMI difference (kg/m^2), mean (range)	10.71 ± 5.53 (−3.44; 22.96)
Weight difference (lbs), mean (range)	−68.52 ± 35.65 (−151, 24)
Total weight loss (%), mean (range)	23.26 ± 10.37 (−9.38; 44.13)
Excess weight loss (%), mean (range)	53.93 ± 23.35 (−29.36; 94.88)
24-month follow-up, n	Population (of denominator N = 18)
BMI ≤35 kg/m^2, n, mean (SD)	12, 31.56 (2.83)
BMI >35 kg/m^2, n, mean (SD)	6, 39.79 (2.44)
BMI difference (kg/m^2), mean (range)	11.09 ± 6.91 (−6.6; 23.11)
Weight difference (lbs), mean (range)	−71.5 ± 45.69 (−152; 46)
Total weight loss (%), mean (range)	23.44 ± 13.77 (−17.97; 43.06)
Excess weight loss (%), mean (range)	51.56 ± 32.24 (−56.27; 87.76)

Table 4 Post-Surgery weight loss evolution over 24 months

Time period	BMI, Kg/m^2		Weight, Kg		%TWL			%EWL		
	LRYGB	Sleeve	LRYGB	Sleeve	LRYGB	Sleeve	*P*-value	LRYGB	Sleeve	*P*-value
Pre-surgery	44.23±6.55	44.54±6.25	289.75±54.81	285.65±64.60						
3 months	35.68±3.03	36.43±4.31	234.92± 37.01	226.17± 33.93	12.44±6.74	16.49±8.28	0.1913	31.57±16.54	39.05±18.67	0.2993
6 months	36.43±5.70	37.3±5.30	237.22± 45.31	237.69± 57.88	16.42±7.37	16.52±8.04	0.9703	40.90±21.81	38.66±18.66	0.7579
1 year	33.67±4.88	34.43±3.64	219.37± 41.74	215.9± 31.74	23.15±11.25	23.46±8.90	0.9409	54.55±26.95	52.77±15.50	0.8491
18 months	33.55±6.32	29.94±0.19	216.73± 49.87	175± 29.70	22.39±15.09	27.07±8.54	0.6851	53.52±40.61	68.33±10.07	0.6295
2 years	33.95±5.18	35.21±3.92	222.46± 40.70	224.2± 40.09	23.33±15.61	23.72±8.60	0.9582	51.24±37.34	52.38±15.30	0.949

LRYGB laparoscopic Roux-en-Y gastric bypass, *BMI* body mass index, *%EWL* percent excess weight loss, *%TWL* percent total weight loss

The values are expressed as mean ± standard deviation

remained significantly more likely to meet the target BMI of ≤35 kg/m^2 at 12 months (adjusted RR [95% CI] = 3.76 [1.38, 10.24], *P*=0.010). No other factors were significantly associated with achieving a target BMI of ≤ 35 kg/m^2 at 12 months (Table 5).

Of the 38 patients having bariatric surgery to increase their eligibility to be listed for a kidney transplant, 18 patients (47%) were able to be listed for a transplant, and 8 patients (21%) had undergone kidney transplantation (5 post-LRYGB and 3 post-LSG). Analysis of post-transplant outcomes of these patients showed no reported perioperative morbidity or mortality, no delayed graft function, or allograft failure over follow-up period of 1–23 months.

Discussion

Our study is one of the larger series to date for patients with CKD G5D having bariatric surgery where the majority underwent a gastric bypass as opposed to sleeve gastrectomy with further potential benefits for patients with metabolic disorders. We demonstrate that 46% of patients were able to achieve a target BMI of <35 at 6 months after surgery and 75.8% achieved the target BMI in 1 year. This is consistent with reported series by Jamal et al. evaluating 21 patients with CKD G5D undergoing bariatric surgery, 18 of which had a gastric bypass. Sixteen patients (76%) achieved BMI of <35 over follow-up period of 2.3 years [15]. Other larger case series of 198 patients with CKD G5D undergoing a sleeve gastrectomy reported that nearly half of patients achieved BMI of less than 35 kg/m^2 over mean follow-up period of 2.3 years [2].

At the 2-year mark, our study showed a reduction in percentage of patients who continued to maintain BMI of less than 35 kg/m^2, as 69% of patients at 12 months had BMI less than 35 kg/m^2 vs 66.7% at 24 months. With weight loss potentially reaching a plateau at the 1-year mark and beyond, there may be an argument to optimize these patients for listing as soon as possible in order to avoid missing a window for transplantation. However, it is difficult to draw strong conclusions due to limited follow-up beyond 2 years. A longer follow-up period is required to monitor the trend of BMI following transplantation surgery. Cohen et al. have described that for patients with pre-transplant bariatric surgery, the median BMI was still <40 kg/m^2 at 5-year post-transplant despite weight gain [@12]. This population should mirror the long-term outcomes of the larger severely obese cohort undergoing bariatric surgery [16, 17].

We found that baseline BMI <45 kg/m^2 was independently associated with higher chance of sufficient weight reduction to secure transplant eligibility compared to those starting above that baseline. This is consistent with the recently published data that showed that changes in weight after sleeve gastrectomy are directly related to the baseline BMI [18]. Nevertheless, when analyzing the patients with initial BMI >45 and > 50 kg/m^2 at baseline, both still lost a substantial amount of weight and at 12 months had a BMI of around 36 kg/m^2. This is close enough to target BMI that more intense multidisciplinary management of their weight could allow a number of these patients to reach the threshold for transplant consideration.

At this point, one might raise the obesity paradox in CKD G5D and the potential beneficial effects of obesity in such patients as a counterpoint to the strategy entailed by this study. However, the obesity paradox should not be a barrier in advising weight loss to patients suffering from severe obesity. These benefits of obesity mainly span in the overweight to mildly obese range, whereas there is enough evidence on adverse outcomes in patients suffering from severe obesity with a BMI > 40 kg/m^2 to refute using the obesity paradox as an excuse to prevent weight loss, either before or after transplant [19–21].

In addition, we are able to demonstrate in our cohort that bariatric surgery in CKD G5D patients is relatively safe and effective with no mortality, a 30-day readmission rate of 5.3%,

Table 5 Relative risk of meeting target BMI of 35 at 1 year by risk factor modeled as categorical variable (*N*=38)

Characteristic	*n* (%)	Unadjusted risk ratio (95% CI)	*P*-value	Adjusted risk ratio (95% CI)	*P*-value
Age					
20–29 years	4 (10.5)	1.56 (1.05, 2.31)	0.029	2.60 (0.87, 7.80)	0.089
30–39 years	16 (42.1)	Ref		Ref	
40–49 years	10 (26.3)	1.04 (0.52, 2.09)	0.919	1.04 (0.46, 2.33)	0.927
50–59 years	8 (21.1)	1.04 (0.52, 2.09)	0.919	0.40 (0.13, 1.30)	0.129
Gender					
Male	18 (47.4)	Ref		Ref	
Female	20 (52.6)	0.86 (0.53, 1.41)	0.553	1.15 (0.39, 3.42)	0.799
Race					
White	16 (42.1)	Ref		Ref	
Black	19 (50.0)	0.98 (0.58, 1.67)	0.947	0.90 (0.53, 1.53)	0.692
Asian	1 (2.6)	1.43 (0.95, 2.16)	0.090	12.00(2.15, 66.92)	0.005
Unknown/other	2 (5.3)	0.71 (0.16, 3.11)	0.654	0.34(0.093, 1.21)	0.096
Procedure type					
LRYGB	24 (63.2)	Ref		Ref	
Sleeve	14 (36.8)	1.02 (0.61, 1.72)	0.09	0.65(0.27, 1.59)	0.348
Number of comorbidities					
2 or fewer	6 (15.8)	Ref		Ref	
3–4	25 (65.8)	0.89 (0.46, 1.71)	0.724	1.40 (0.79, 2.47)	0.251
5–6	7 (18.4)	0.42 (0.44, 2.26)	1.000	0.72 (0.23, 2.24)	0.572
BMI baseline ≤ 45 kg/m^2					
Yes	23 (60.5)	2.44 (1.20, 4.97)	0.014	3.76 (1.38, 10.24)	0.010
No	15 (39.5)	Ref	Ref		
Therapeutic anticoagulation					
Yes	5 (13.2)	1.56 (1.16, 2.11)	0.003	5.43 (0.76, 38.67)	0.091
No	33 (86.8)	Ref		Ref	

LRYGB laparoscopic Roux-en-Y gastric bypass

a 5.3% transfusion rate, and no leaks. Although we did have 2 cases of reoperation and intervention, the 2 reoperations were performed in sleeve gastrectomy patients and not the gastric bypass cohort. There has generally been a case made for performing a sleeve gastrectomy in these higher risk patients to minimize risk, but the few publications that have been with gastric bypass patients have shown similar outcomes [2, 15]. Our length of stay was lower with an average of 2.3 days, compared to lengthier hospital stays in previously described literature [2, 22, 23]. Prior data suggest that patients with CKD G5D have increased risk of mortality, reoperation, and intervention [12, 15]. Our findings are in line with findings from the MBSAQIP that patients with kidney insufficiency are at increased risk of post-operative bleeding, both due to their renal failure, as well as a higher ratio of patients are on long term anticoagulants which formed 13.2% of our cohort [24].

In total, 8 (21%) of patients in our cohort were transplanted, and 47% were listed for a kidney transplant. However, with longer follow-up, this rate may increase significantly as the patient spends an increasing amount of time on the transplant list and more organs become available. This is comparable to other published series; Kassam et al. reported that 36% of their study population successfully listed and 23% received kidney transplantation [2]. Recent systematic review and meta-analysis from France published in December 2020 included a total of 18 case reports and series reported outcomes of bariatric surgery in patients with CKD G5D. The included series had heterogenous patient populations. It demonstrated safety and efficacy of bariatric surgery with improved comorbidities, and 20% of the patients got successfully transplanted [25].

Not all patients were able to be listed or to get kidney transplantation because of many factors that determine transplant eligibility other than weight. These factors include uncontrolled medical comorbidities, socioeconomic status, insurance concerns, and psychosocial issues. Likewise, the average waiting time on the kidney transplant list is 5 years, so it is not surprising that several patients have been listed but not transplanted yet [26].However, the benefits of weight loss they received may help improve survival while they are waiting for an appropriate donor. Sheetz et al. compared a cohort of 1597 patients suffering from obesity with chronic kidney disease who underwent bariatric surgery compared with a matched cohort of 4750 nonsurgical patients receiving usual care for their obesity. He demonstrated that bariatric surgery was associated with lower all-cause mortality over a follow-up period of 5 years [27]. Furthermore, several studies have also described improvement in medical comorbidities following bariatric surgery in patients with kidney failure while waiting for a kidney transplant [2, 6]. Therefore, there is a potential implication for the selection of CKD5 patients who are slated to go down this pathway of access-enhancing obesity management with bariatric surgery that could optimize the approaches to this group of patients.

Our study has several limitations including but not limited to a retrospective case series; hence, there is inherent selection bias, missed follow-up data with missing observations, and unbalanced samples across time units (most of the patients had bariatric surgery in the latter part of the study period). Our study is also based on a single institution's experience and relatively small sample size, which might prevent us from drawing firm conclusions, as the power of study is limited. Our follow-up period is only 2 years, and we think that longer follow-up is required to monitor the BMI trend, effects of bariatric surgery on immunosuppression, as well as allograft function as described in other literature. Further studies are needed to determine the safety and efficacy of bariatric surgery in patients with CKD G5D. We propose collaborating with other large bariatric and transplant institutions to conduct a multi-institutional prospective propensity matched study comparing patients suffering from severe obesity with CKD G5D who undergo bariatric surgery with those who remain on hemodialysis.

Conclusion

Bariatric surgery has significant, sustainable effects on weight loss and improves transplant candidacy effectively and can successfully move patients through the care pathway to transplantation. With around 14% of patients with CKD G5D suffering from severe obesity, increasing their chance of transplant eligibility could result in significant long-term cost savings to health systems as well.

Author Contribution All of the listed authors contributed equally in (a) substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; (b) drafting the article or revising it critically for important intellectual content; and (c) final approval of the version to be published.

Declarations

Ethical Approval For this type of study, formal consent is not required.

Informed Consent Statement Informed consent does not apply.

Conflict of Interest The authors declare no competing interests.

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