Bariatric surgery is associated with improvement in kidney outcomes

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Severe obesity is associated with increased risk of kidney disease. Whether bariatric surgery reduces the risk of adverse kidney outcomes is uncertain. To resolve this we compared the risk of estimated glomerular filtration rate (eGFR) decline of ≥30% and doubling of serum creatinine or end-stage renal disease (ESRD) in 985 patients who underwent bariatric surgery with 985 patients who did not undergo such surgery. Patients were matched on demographics, baseline body mass index, eGFR, comorbidities, and previous nutrition clinic use. Mean age was 45 years, 97% were white, 80% were female, and 33% had baseline eGFR <90 ml/min per 1.73 m^2. Mean 1-year weight loss was 40.4 kg in the surgery group compared with 1.4 kg in the matched cohort. Over a median follow-up of 4.4 years, 85 surgery patients had an eGFR decline of ≥30% (22 had doubling of serum creatinine/ESRD). Over a median follow-up of 3.8 years, 177 patients in the matched cohort had an eGFR decline of ≥30% (50 had doubling of serum creatinine/ESRD). In adjusted analysis, bariatric surgery patients had a significant 58% lower risk for an eGFR decline of ≥30% (hazard ratio 0.42, 95% confidence interval 0.32–0.55) and 57% lower risk of doubling of serum creatinine or ESRD (hazard ratio 0.43, 95% confidence interval: 0.26–0.71) compared with the matched cohort. Results were generally consistent among subgroups of patients with and without eGFR <90 ml/min per 1.73 m^2, hypertension, and diabetes. Thus, bariatric surgery may be an option to prevent kidney function decline in severely obese individuals.

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Obesity (body mass index [BMI] ≥30 kg/m^2) affects more than 1 in 3 adults in the United States and is associated with the development of numerous chronic conditions including hypertension, diabetes, cardiovascular disease, cancer, and chronic kidney disease (CKD).[1,2] The risk of end-stage renal disease (ESRD) is particularly elevated in patients with severe obesity.[3,4] Compared with patients with a BMI of 18.5 to 24.9, patients with a BMI of 35 to 39.9 or a BMI ≥40 kg/m^2 had a 512% and 607% increased risk of ESRD, respectively.[3] Potential mediators of this relationship include increased blood pressure, blood glucose, inflammation, dysregulated production of adipocytokines, and the adverse effects of glomerular hyperfiltration.

Bariatric surgery is very effective for inducing sustained weight loss, lowering blood pressure, improving glycemic control, and causing diabetes remission.[5–7] However, evidence of the effects of bariatric surgery on CKD outcomes is sparse. Previous studies have been limited by small sample sizes or relatively short duration of follow-up.[8–11] The long-term effects of surgical weight loss on kidney function are uncertain.

Using a cohort of bariatric surgery patients and a propensity-matched cohort of obese patients who did not undergo surgery, we examined the incidence rates of kidney function decline during follow-up of up to 9 years.

RESULTS

Baseline characteristics

Overall, baseline characteristics of participants in the surgery and matched nonsurgery cohorts were similar (Table 1 and Supplementary Figure S1). Mean values of age, weight, and eGFR were 45 years, 129 kg, and 97 ml/min per 1.73 m^2 for both groups. The majority of patients were female (surgery patients, 79%; nonsurgery patients, 80%) and white (97% for both groups). Both groups had similar prevalence of hypertension (surgery patients, 62%; nonsurgery patients, 61%), diabetes (surgery patients, 38%; nonsurgery patients, 36%), and metabolic syndrome (surgery patients, 74%; nonsurgery patients, 76%) with small but significant differences in systolic blood pressure (surgery patients, 133 mm Hg; nonsurgery patients, 129 mm Hg). The prevalence of eGFR <60 ml/min per 1.73 m^2 (5% for both groups) and an

Table 1 | Baseline characteristics of bariatric surgery patients and matched controls

	Matched surgery patients	Matched control patients	*P* value
N	985	985	
Age, yr	45.5 (11.1)	45.0 (12.0)	0.3
Female	79	80.4	0.4
Black	2.8	2.6	0.8
Weight, kg	129.0 (26.4)	128.7 (26.5)	0.8
BMI, kg/m^2	46.4 (7.8)	46.4 (8.3)	0.9
SBP, mm Hg	132.7 (16.9)	129.2 (15.5)	<0.001
DBP, mm Hg	76.9 (9.6)	77.3 (10.3)	0.4
eGFR, ml/min per 1.73 m^2	97.2 (19.5)	97.2 (20.1)	0.9
<60	4.7	4.6	0.9
60–89	27.5	27.6	1
>90	67.8	67.8	1
Smoking status			0.9
Current	6.5	6.8	
Former	30.5	30.6	
Never	46.2	47.2	
Diagnoses[a]			
Hypertension	61.9	61.2	0.7
Type 1 diabetes	1.9	2.2	0.6
Type 2 diabetes	37.8	35.6	0.3
Dyslipidemia	53.4	54.1	0.8
Metabolic syndrome	73.7	76.4	0.2
Kidney calculus	3.0	2.6	0.6
Gout	2.6	2.6	1
Heart failure	3.0	3.0	1
MI	0.8	1.1	0.5
History of AKI	0.1	0.1	1
Taking a statin	22.8	23	0.9
Taking an ACEI or ARB	23.2	22.8	0.8
Taking a diuretic	26.2	29.1	0.1
Taking metformin	27.2	25.8	0.5
Taking insulin	8.2	8.8	0.6
Visit to a nutrition clinic	99.6	99.6	1
Surgery type			
Roux-en-Y	96.5		
Sleeve	3.5		

Values are presented as mean (SD) or percentage.
ACEI, angiotensin-converting enzyme inhibitor; AKI, acute kidney injury; ARB, angiotensin receptor blocker; BMI, body mass index; DBP, diastolic blood pressure; eGFR, estimated glomerular filtration rate; MI, myocardial infarction; SBP, systolic blood pressure.
[a]Diagnoses were identified from International Classification of Diseases, Ninth Revision, codes except for metabolic syndrome, which was determined based on diagnosis codes, use of antihypertensive and diabetes medications, and fasting laboratory values.

eGFR of 60 to 89 ml/min per 1.73 m^2 (28% for both groups) was similar. Nearly all patients in both groups (99.6%) visited a nutrition clinic at Geisinger. The vast majority of surgery patients underwent Roux-en-Y bypass surgery (96.5%) with a small minority undergoing gastric sleeve surgery (3.5%).

Trajectories of weight, blood pressure, and prevalence of diabetes

The median duration of follow-up for the surgery and nonsurgery matched cohort was 4.4 (interquartile range, 2.1–6.3) years and 3.8 (interquartile range, 1.7–6.6) years, respectively. After 1 year, weight decreased by an average of 40.4 kg in the surgery group (Figure 1). At the end of 5 years, the surgery group regained an average of 6.2 kg, such that the average 5-year weight loss was 34.2 kg. On average, the nonsurgery-matched cohort experienced minimal weight loss (1.4 kg at 1 year, 1.3 kg at 5 years). The surgery group had a small decline in systolic blood pressure during follow-up, whereas the nonsurgery cohort had stable blood pressure (Supplementary Figure S2). There were also smaller increases in the prevalence of hypertension and diabetes in the surgery group than the non-surgery group (Supplementary Figures S3 and S4).

Risk of an eGFR decline of ≥30%

A total of 85 patients in the surgery group and 177 patients in the nonsurgery cohort had an eGFR decline of ≥30%. Corresponding incidence rates of an eGFR decline of ≥30% were 20.2 per 1000 person-years in the surgery group and 48.2 per 1000 person-years in the nonsurgery-matched cohort (Table 2). Individuals who underwent bariatric surgery had a 58% lower risk (hazard ratio [HR] 0.42, 95% confidence interval [CI] 0.32–0.55, $P < 0.001$) of the development of an eGFR decline of ≥30% compared with the nonsurgery patients. Adjustment for incident hypertension and incident diabetes only slightly attenuated the protective association between bariatric surgery and an eGFR decline of ≥30% (HR 0.46, 95% CI 0.36–0.60, $P < 0.001$).

On stratified analysis, bariatric surgery was associated with a significantly lower risk of an eGFR decline of ≥30% in both patients with a baseline eGFR <90 ml/min per 1.73 m^2 (HR 0.37, 95% CI 0.24–0.56, $P < 0.001$) and patients with a baseline eGFR of ≥90 ml/min per 1.73 m^2 (HR 0.46, 95% CI 0.33–0.65, $P < 0.001$; P value for interaction = 0.4). Similarly, the association between bariatric surgery and a lower risk of an eGFR decline persisted in subgroups by hypertension and diabetes status (P value for interaction terms > 0.05). In patients with and without hypertension, bariatric surgery was associated with a 60% and 52% decreased risk of an eGFR decline of ≥30%, respectively (HR 0.40, 95% CI 0.30–0.54, $P < 0.001$; HR 0.48, 95% CI 0.29–0.80, $P = 0.005$). In patients with and without diabetes, bariatric surgery was associated with a 55% and 64% decreased risk of an eGFR decline of ≥30%, respectively (HR 0.45, 95% CI 0.32–0.64, $P < 0.001$; HR 0.36, 95% CI 0.24–0.54, $P < 0.001$).

On sensitivity analysis requiring at least 2 follow-up eGFR levels demonstrating a ≥30% decline, the median time between creatinine measurements was 142 days (interquartile range, 52–448). Results appeared similar, if not stronger; individuals who underwent bariatric surgery had a 66% decreased risk of an eGFR decline of ≥30% compared with the nonsurgery cohort (HR 0.34, 95% CI 0.23–0.48, $P < 0.001$) (Supplementary Figure S5).

Risk of doubling of serum creatinine or ESRD

A total of 22 patients in the surgery group and 50 patients in the nonsurgery matched cohort experienced either doubling of serum creatinine or ESRD. Specifically, ESRD eventually occurred in 8 surgery patients and 10 nonsurgery patients. The incidence rates of doubling of serum creatinine or ESRD were 5.0 per 1000 person-years in the surgery group and 12.4 per 1000 person-years in the nonsurgery patients