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A Critical Analysis of Perioperative Outcomes in Morbidly Obese Patients Following Renal Mass Surgery

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Abstract

OBJECTIVE—To evaluate if body mass index (BMI) ≥ 40 is associated with risk of postoperative complications, receipt of perioperative blood transfusion (PBT), length of hospital stay (LOS), perioperative death, or hospital readmission rate following renal mass surgery.

MATERIALS AND METHODS—After Institutional Review Board approval, comprehensive information was collected for patients treated with surgery for renal mass from 2000 to 2015 at one institution. Univariable and multivariable analyses were used to evaluate the association of BMI ≥ 40 among other putative risk factors for perioperative outcomes.

RESULTS—A total of 1048 patients were treated surgically, including 115 (11%) with BMI > 40 . Minimally invasive and open surgical approaches were used for 480 (45.8%) and 568 (54.2%) patients, respectively. Morbid obesity was not associated with risk of major complications, overall complications, receipt of PBT, LOS, hospital readmission rate, or perioperative death. Charlson comorbidity index was the only independent predictor of major complications following renal mass surgery, $P = .0006$, per point odds ratio 1.2 (95% C.I. 1.08–1.32). Surgical site infections (SSIs) were more common in patients with BMI ≥ 40 vs BMI < 40 (10.5% vs 4.8%, $P = .01$). Following multivariable analysis, BMI ≥ 40 was the only independent predictor of SSIs, odds ratio 2.6, 95% confidence interval 1.32–5.13; $P = .006$.

CONCLUSION—Morbid obesity (BMI ≥ 40) is an independent predictor of developing SSIs following renal mass surgery. Morbid obesity is not predictive of risk for major complications, receipt of PBT, hospital readmission, perioperative death, or LOS.

The World Health Organization defines the most severe form of obesity as class 3, morbid, or extreme obesity for patients with body mass index (BMI) ≥ 40 .¹ These patients have the highest prevalence of comorbidities and a shortened life expectancy.² When compared to

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APPENDIX

Supplementary Data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.urology.2016.06.018>.

patients defined as overweight (BMI 25–29.9) or mildly obese (BMI 30–34.9), morbidly obese patients are more likely to have serious health problems, including: hypertension, diabetes, coronary artery disease, cerebrovascular disease, dyslipidemia, sleep apnea, osteoarthritis, liver disease, and respiratory dysfunction.^{3,4} Given the rapidly rising incidence of morbid obesity in the United States^{2,3} and the increased prevalence of renal cell carcinoma (RCC) among obese patients,^{5,6} it is critical to consider how severe obesity affects perioperative outcomes in patients undergoing renal surgery.

Several studies have demonstrated that surgical procedures using general anesthesia are more technically difficult in morbidly obese patients,⁷ and potentially result in worse perioperative outcomes.^{8,9} Furthermore, extremely obese patients have a higher incidence of comorbidities, which are associated with an increased risk for postoperative complications following RCC surgery,¹⁰ but there are minimal data that specifically evaluate perioperative outcomes for extremely obese patients. The objective of this study was to evaluate if morbid obesity (BMI ≥ 40) is associated with increased risk of postoperative complications, receipt of perioperative blood transfusion (PBT), length of hospital stay (LOS), or hospital readmission rate following renal cancer surgery.

MATERIALS AND METHODS

After Institutional Review Board approval, an institutional database identified patients treated with either radical or partial nephrectomy for renal mass from January 2000 until September 2015 at our institution. Comprehensive clinical and pathologic information was collected for each patient including Charlson comorbidity index (CCI) without adding points for age or urological cancer diagnosis, and R.E.N.A.L. nephrometry score as described previously.¹¹ Tumor stage and pathologic definitions were assigned using the American Joint Committee on Cancer 8th edition and 2013 International Society of Urological Pathology statement.¹² Perioperative transfusions were defined as occurring within 30 days after surgery. Complications occurring within 90 days of surgery were classified according to the Clavien-Dindo system.¹³

Univariable and multivariable logistic regression was used to evaluate the association of BMI ≥ 40 among other clinical and pathologic variables with perioperative complications. Significant variables following univariable analysis were used for multivariable analysis. Specific predictors of hospital readmission within 30 days postoperatively and LOS were evaluated using Wilcoxon rank-sum tests and Spearman correlation coefficients, and a general linear model was used to perform multivariate analysis when appropriate. A *P* value < .05 was considered statistically significant and the SAS 9.4 (SAS Institute, Cary, NC) was used for all analyses.

RESULTS

A total of 1048 patients underwent renal surgery from 2000 to 2015, including 115 (11.0%) patients with BMI ≥ 40. Overall median BMI was 29.5 (interquartile range 25.8–34.6). Baseline clinical and pathological characteristics for each of these groups are shown in Table 1. Morbidly obese patients were more likely to be younger (*P* = .003), have a diabetes

diagnosis ($P < .0001$), use metformin ($P = .001$), have a flank incision ($P = .03$), and were less likely to have distant metastases at presentation ($P = .02$). The most common pathology was RCC in 894 (85.3%) followed by 132 (12.6%) benign renal neoplasms (angiomyolipoma, oncocytoma, benign cystic masses), and other malignant neoplasms in 22 (2.1%), including sarcomas, lymphoma, squamous cell cancer, and metastatic cancer from other sites.

Major Complications

A total of 76 patients (7.3%) experienced a major complication (Clavien 3) within 90 days of surgery. Cardiovascular and pulmonary complications accounted for the majority of major complications, occurring in 44 (59.5%) patients. In addition, infectious, gastrointestinal, hematologic, and genitourinary complications occurred in 8, 8, 7, and 9 patients, respectively. Urine leak requiring intervention occurred in 7 of 222 patients who underwent partial nephrectomy. Also, percentage is 3.2%.

Patients with BMI ≥ 40 were not more likely to experience major complications (odds ratio [OR] 0.57, 95% confidence interval [CI] 0.22–1.44; $P = .23$) (Table 2). The only independent predictors of major complications were CCI (per point) (OR 1.18, 95% CI 1.07–1.31; $P = .001$) and incision type ($P = .02$). Nineteen (1.8%) patients died within the first 90 days following surgery. There was no difference in rate of perioperative mortality for patients with BMI ≥ 40 and BMI < 40 (3.6% vs 1.7%, $P = .15$).

A separate multivariate analysis was performed to evaluate association with major complications for the 894 patients with RCC treated surgically. Putative risk factors that were analyzed included approach, radical vs partial nephrectomy, 2009 American Joint Committee on Cancer TNM stage, presence of venous thrombus, concurrent lymph node dissection, BMI, CCI, age, smoking status, and year of surgery. Independent predictors of major complications among surgically treated patients with RCC included presence of venous thrombus (OR 2.94, 95% CI 1.72–5.01; $P < .0001$) and CCI (per point) (OR 1.19, 95% CI 1.08–1.32; $P = .007$).

Overall Complications Within the First 90 Days

Complications were identified in 246 (24.1%) patients during the 90 days following surgery. The most common complications were infectious (urinary tract infection, surgical site infection [SSI], *Clostridium difficile* colitis, etc.) in 103 (37.6%) patients; cardiovascular (myocardial infarction, arrhythmias, cerebrovascular accident, etc.) in 42 (15.3%) patients; pulmonary (respiratory failure, pleural effusion, pneumothorax, etc.) in 42 (15.3%) patients; gastrointestinal (ileus, bowel obstruction, pancreatitis etc.) and hematologic (symptomatic hematoma, hemorrhage, venous thromboembolic events, pseudoaneurysm) in 23 (8.4%) patients; genitourinary (acute kidney injury, unplanned dialysis, urine leak, etc.) in 16 (5.8%) patients; and miscellaneous complications (allergic reactions, chronic pain, corneal abrasion, etc.) in 20 (8.1%) patients. Predictors of overall complications following surgery are shown in Table S1.

Initial analysis identified BMI ≥ 40 as a predictor of higher risk for overall complication (OR 1.81, 95% CI 1.19–2.75; $P = .006$). However, SSIs were disproportionately represented

in the group with BMI ≥ 40 when compared to patients with BMI < 40 (10.7% vs 4.2%, $P = .003$). If SSIs are subsequently excluded from the analysis of predictors of complications, BMI > 40 is not associated with overall complications following surgery. Predictors of overall complications excluding SSI are shown in Table 3. Independent predictors of any complication following renal cancer surgery included age (per year) (OR 1.02, 95% CI 1.00–1.03), RCC vs other renal tumors (OR 0.51, 95% CI 0.29–0.90; $P = .02$) and incision type ($P = .0001$).

SSIs

SSIs were identified in 50 (4.9%) patients overall. The only independent predictor of developing SSI was BMI ≥ 40 (OR 2.74, 95% CI 1.39–5.42; $P = .004$). A total of 181 (17.5%) patients had a diagnosis of diabetes at the time of surgery. Post-operative wound infections were not associated with diabetes diagnosis (OR 1.52, 95% CI 0.78–2.96, $P = .22$), insulin use (OR 0.97, 95% CI 0.33–2.81, $P = .95$), or metformin use (OR 1.49, 95% CI 0.56–3.98, $P = .43$). Overall, 16 (1.5%) patients developed an incisional hernia following renal mass surgery. Prior abdominal surgery was not associated with increased risk of developing SSI ($P = .09$). Risk of developing incisional hernia was associated with neither BMI > 40 or prior SSI.

Receipt of Blood Transfusion

PBT within 30 days following surgery was received by 186 (17.8%) patients overall, and 98 (11.2%) for 875 patients without venous thrombus. Morbid obesity was not associated with increased risk of transfusion (OR 1.11, 95% CI 0.68–1.81; $P = .69$). After multivariate analysis, the presence of venous tumor thrombus (OR 2.33, 95% CI 1.52–3.93; $P = .0002$), CCI per point (OR 1.14, 95% CI 1.04–1.25; $P = .004$), and incision type ($P < .0001$) were associated with increased risk of receiving blood transfusion.

Length of Hospitalization and Readmission Rates

Median hospital LOS was 4 days (interquartile range 3–6). BMI ≥ 40 was not associated with longer LOS ($P = .06$). Independent predictors of increased LOS after multivariate analysis included age ($P < .0001$), incision type ($P < .0001$), presence of venous tumor thrombus ($P < .0001$), and CCI ($P = .02$). A total of 52 (5.1%) patients were re-admitted to the hospital within 30 days of surgical discharge. Morbid obesity (BMI ≥ 40) was not associated with higher readmission rates ($P = .56$). CCI per point was the only predictor of hospital readmission (OR 1.17, 95% CI 1.04–1.31; $P = .009$).

Expanded Analysis of BMI Impact

In a separate analysis, BMI (per point) was evaluated as a continuous variable and was not associated with risk of major complications ($P = .83$) but was associated with SSI risk ($P = .0002$). A second additional analysis compared outcomes for patients with ideal body weight (BMI 20–24.9) to overweight (BMI 25–29.9), obese (BMI 30–39.9), and morbidly obese (BMI ≥ 40) patients. There was no difference in risk of major complications among the 4 groups ($P = .36$). However, a sequential increase in SSI risk ($P = .003$) was demonstrated with increase in BMI: ideal BMI (referent), overweight BMI (OR 1.5, 95% CI 0.5–4.8),

obese BMI 30–39.9 (OR 3.2, 95% CI 1.1–9.2), and morbidly obese BMI (OR 5.7, 95% CI 1.8–18.0).

DISCUSSION

Patients with morbid obesity may weigh 100 pounds or more over their ideal body weight and have a high incidence of serious health problems.^{3,4} Morbid obesity may increase the technical difficulty of surgery,¹⁴ the risk for SSIs,¹⁵ and perioperative complications.^{7,16} The current study has identified that BMI ≥ 40 is an independent predictor of risk for developing postoperative wound infections. Notably, patients with BMI ≥ 40 did not have higher rates of major complications, PBTs, hospital readmission, or longer hospitalization following surgery compared to patients with lower BMI. This study suggests that the presence of comorbidities and not obesity itself predicts the risk of major complications, and renal surgery should remain a standard treatment for well-selected patients regardless of obesity. Further studies should investigate strategies to decrease wound infection in extremely obese patients.

With the exception of SSIs, this study identified no difference in postoperative outcomes for patients with BMI ≥ 40. Prior studies of obese patients following renal surgery do not separately evaluate outcomes for the most obese patients, or contain only a few morbidly obese patients.^{17–21} Patients with BMI ≥ 40 comprised 18 of 1336(1.3%) and 28 of 250 (11.2%) in recent studies that specifically evaluate surgical outcomes of RCC and obesity.^{22,23} In the current study, there are 115 (11.0%) patients with BMI ≥ 40 with a renal mass treated surgically, although the statewide incidence of morbid obesity is only 2.8%.²⁴ This relatively large cohort of morbidly obese patients allows for a better evaluation of perioperative outcomes, which is important, given the rising incidence of extreme obesity.

Several prior studies have reported outcomes following minimally invasive surgery in obese patients.^{18,19,23} In the current study, use of a laparoscopic or robotic approach was not independently associated with overall complications, major complications, wound complications, or hospital re-admission, although minimally invasive approaches were associated with decreased incidence of blood transfusion and shorter hospital stay after surgery. Charlson comorbidity index is a known predictor of complications following kidney surgery¹⁰ and was associated with higher risk of major complications, blood transfusion, and hospital readmission in the current series. Although comorbidities are reported as more common in morbidly obese patients,^{2–4} the median CCI was similar between BMI ≥ 40 patients and BMI < 40 cohorts in this study, which likely reflects selection of healthier patients for surgery in both cohorts. The results of these analyses suggest that worse outcomes are associated with presence of comorbidities and not extreme obesity itself, although surgery may be more technically challenging.

Significantly higher rates of SSIs were demonstrated for morbidly obese patients following renal surgery, and strategies to decrease wound infections in this patient population deserve further study. In nonurologic surgery, multiple studies have described an increased risk of SSI for morbidly obese patients; however, the mechanism underlying the increased risk remains unclear.^{8,25} The use of antibiotic prophylaxis prior to surgery is a well-established

practice, with recent evidence suggesting that extended antibiotic prophylaxis (EAP) may benefit certain high-risk patients. In a recent cohort study, obese patients following combined hysterectomy and panniculectomy who received EAP were significantly less likely to develop SSI vs standard preoperative antibiotics.²⁶ However, EAP also increases the risk of *C. difficile* infection,²⁷ and must be used with caution. Clinical trials have also investigated whether high concentration-inspired oxygen may decrease SSI by increasing incisional tissue oxygenation, but a recent meta-analysis demonstrated discouraging results.²⁸ Prophylactic placement of subcutaneous drains at the time of surgery is also common in bariatric, colorectal, and gynecologic surgery. However, data demonstrating efficacy of drains to reduce SSI are limited,^{29–31} with a recent study suggesting that subcutaneous drains may reduce the risk of SSI in selected patients with subcutaneous fat thickness of >2 cm on axial imaging or for patients undergoing emergent operations.³²

Limitations of this study include its retrospective analysis and biases associated with selection of patients for surgery. Multivariable analyses were used to consider effects of baseline differences between BMI ≥ 40 or <40 cohorts but there exists a possibility for unmeasured bias favoring selection of healthier patients for surgery. However, the disproportionate representation of morbidly obese patients in our cohort (371% of the regional incidence of morbid obesity) argues against favorable selection of only healthy obese patients. Finally, because our center has significant experience with care of extremely obese patients, it is possible that these findings may not be generalizable to a community hospital setting and morbidly obese patients should generally not be expected to have identical results to ideal weight patients given the increase in technical difficulty for surgery in these patients. Furthermore, high BMI patients may benefit from surgery at tertiary centers because of the availability of specialized bariatric equipment such as high weight capacity operating room tables, hospital beds, and computed tomography scanners, or larger rooms with more aggressive postsurgical physical therapy. In addition, anesthesia providers and nursing staff play critical roles in perioperative and postoperative care and should be experienced in specialized care of bariatric patients.

CONCLUSION

Morbid obesity (BMI ≥ 40) is an independent predictor of risk for developing postoperative SSIs following renal mass surgery. Well-selected morbidly obese patients do not have higher rates of major complications, PBTs, hospital read-mission, or longer length of hospitalization. Surgery for renal masses should be a standard treatment for well-selected patients regardless of obesity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Patient and disease characteristics

	All N = 1048	BMI <40 N = 933	BMI 40 N = 115	P Value
Median age (IQR)	59.2 (50.2–67.7)	60 (50.6–68.4)	56.5 (49.6–62.8)	.003
Median BMI	29.5 (25.8–34.6)	28.6 (25.3–32.4)	44.4 (41.3–49.7)	
Median CCI	0 (0–2)	0 (0–2)	1 (0–2)	.53
Diagnosis of diabetes	181 (17.5)	144 (15.7)	37 (32.2)	<.0001
Insulin use	73 (11.3)	60 (10.6)	13 (16.7)	.11
Metformin use	65 (10.1)	49 (8.7)	16 (20.5)	.001
Smoking history (%)				.59
Never	431 (44.5)	382 (44.4)	49 (45)	
Current	175 (18.1)	152 (17.7)	23 (21.1)	
Prior history	363 (37.5)	326 (37.9)	37 (33.9)	
2000–2008	524 (50)	468 (50.2)	56 (48.7)	.77
2009–2015	524 (50)	465 (49.8)	59 (51.3)	
Approach				.19
Laparoscopic or robotic	480 (45.8)	434 (46.5)	46 (40.0)	
Open	568 (54.2)	499 (53.5)	69 (60.0)	
Incision type				.03
Flank	300 (28.6)	253 (27.1)	47 (40.9)	
Subcostal	104 (9.9)	93 (10.0)	11 (9.6)	
Midline	94 (9.0)	87 (9.3)	7 (6.1)	
Chevron	70 (6.7)	66 (7.1)	4 (3.5)	
Laparoscopic	480 (45.8)	434 (46.5)	46 (40.0)	
Prior abdominal surgery	506 (49.8)	445 (49.4)	61 (53.0)	.46
Pathology				
Benign renal neoplasms	132 (12.6)	125 (13.4)	7 (6.9)	.06
Other malignancies	22 (2.1)	20 (2.1)	2 (1.7)	
Renal cell carcinoma	894 (85.3)	788 (84.5)	106 (92.2)	
Median nephrometry score	9 (7–10)	9 (7–10)	9 (7–10)	.41
Type of nephrectomy				.58

	All	BMI <40	BMI ≥40	P Value
	N = 1048	N = 933	N = 115	
Partial nephrectomy	222 (24.8)	198 (25.1)	24 (22.6)	
Radical nephrectomy	672 (75.2)	590 (74.9)	82 (77.4)	
T stage				.29
T1	512 (57.4)	452 (57.5)	60 (56.6)	
T2	107 (12)	90 (11.5)	17 (16)	
T3	258 (28.9)	229 (29.1)	29 (27.4)	
T4	15 (1.7)	15 (1.9)	0	
N1	46 (5.2)	41 (5.2)	5 (4.7)	.83
M1	105 (11.7)	100 (12.7)	5 (4.7)	.02
Venous thrombus				
None	721 (80.8)	631 (80.3)	90 (84.9)	.47
Renal vein	101 (11.3)	91 (11.6)	10 (9.4)	
IVC < 2 cm	16 (1.8)	15 (1.9)	1 (0.9)	
IVC > 2 cm	29 (3.3)	28 (3.6)	1 (0.9)	
IVC below diaphragm	12 (1.4)	11 (1.4)	1 (0.9)	
IVC above diaphragm	13 (1.5)	10 (1.3)	3 (2.8)	

BMI, body mass index; CCI, Charlson comorbidity index; IQR, interquartile range; IVC, inferior vena cava.

Table 2.
Risk factors associated with major complications within 90 days of renal mass surgery

Variable	Univariate			Multivariate		
	OR	95% CI	P	OR	95% CI	P
Age	1.02	1.00–1.04	.02	1.01	0.99–1.04	.21
CCI	1.24	1.12–1.36	<.0001	1.18	1.07–1.31	.001
BMI 40 vs BMI < 40	0.57	0.22–1.44	.23			
BMI 35 vs BMI < 35	0.76	0.42–1.39	.38			
Pathology						
Renal cell carcinoma	Ref		.10			
Other	0.49	0.21–1.14				
Incision type						
Flank	Ref		<.0001	Ref		.02
Subcostal	1.74	0.80–3.80		1.28	0.56–2.92	
Midline	1.85	0.83–4.14		1.60	0.70–3.63	
Chevron	4.01	1.92–8.37		2.79	1.18–6.61	
Laparoscopic or robotic	0.61	0.32–1.18		0.66	0.34–1.28	
Smoking status						
Never	Ref		.34			
Former smoker	1.58	0.83–3.03				
Current smoker	1.35	0.78–2.33				
Presence of tumor thrombus	3.29	1.98–5.46	<.0001	1.59	0.84–3.02	.16
Year of surgery						
2000–2008 vs 2009–2015	0.84	0.52–1.36	.48			

CI, confidence interval; OR, odds ratio; other abbreviations as in Table 1.

Table 3.

Clinical and pathological factors associated with risk of any complication within 90 days of renal mass surgery, wound infections excluded

Variable	Univariate			Multivariate		
	OR	95% CI	P	OR	95% CI	P
Age	1.02	1.01–1.03	.001	1.02	1.00–1.03	.02
CCI	1.10	1.03–1.19	.007	1.04	0.97–1.13	.28
BMI 40 vs BMI < 40	1.30	0.82–2.07	.27			
BMI 35 vs BMI < 35	1.06	0.74–1.52	.75			
Approach						
Open	Ref					
Laparoscopic or robotic	0.45	0.33–0.62	<.0001			
Pathology						
Renal cell carcinoma	Ref		.002	Ref		.02
Other	0.42	0.25–0.73		0.51	0.29–0.90	
Incision type						
Flank	Ref		<.0001			.0001
Subcostal	1.65	0.99–2.76		1.39	0.81–2.38	
Midline	1.57	0.91–2.71		1.50	0.86–2.62	
Chevron	2.71	1.55–4.74		2.39	1.26–4.56	
Laparoscopic or robotic	0.62	0.42–0.91		0.60	0.40–0.89	
Smoking status						
Never	Ref		.72			
Former smoker	1.06	0.68–1.65				
Current smoker	1.16	0.82–1.63				
Presence of tumor thrombus	2.23	1.54–3.23	<.0001	1.06	0.66–1.68	.82
Year of surgery						
2000–2008 vs 2009–2015	1.04	0.76–1.41	.82			

Abbreviations as in Tables 1 and 2.