

Robotic partial nephrectomy for renal tumours in obese patients: Perioperative outcomes in a multi-institutional analysis

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Abstract

Introduction: We sought to evaluate the association of obesity with surgical outcomes of robotic partial nephrectomy (RPN) using a large, multicentre database.

Methods: We identified 1836 patients who underwent RPN from five academic centres from 2006–2014. A total of 806 patients were obese (body mass index [BMI] ≥ 30 kg/m²). Patient characteristics and outcomes were compared between obese and non-obese patients. Multivariable analysis was used to assess the association of obesity on RPN outcomes.

Results: A total of 806 (44%) patients were obese with median BMI of 33.8 kg/m². Compared to non-obese patients, obese patients had greater median tumour size (2.9 vs. 2.5 cm, $p < 0.001$), mean RENAL nephrometry score (7.3 vs. 7.1, $p = 0.04$), median operating time (176 vs. 165 min, $p = 0.002$), and median estimated blood loss (EBL, 150 vs. 100 ml, $p = 0.002$), but no difference in complications. Obesity was not an independent predictor of operative time or EBL on regression analysis. Among obese patients, males had a greater EBL (150 vs. 100 ml, $p < 0.001$), operative time (180 vs. 166 min, $p < 0.001$) and warm ischemia time (WIT, 20 vs. 18, $p = 0.001$), and male sex was an independent predictor of these outcomes on regression analysis.

Conclusions: In this large, multicentre study on RPN, obesity was not associated with increased complications and was not an independent predictor of operating time or blood loss. However, in obese patients, male gender was an independent predictor of greater EBL, operative time, and WIT. Our results indicate that obesity alone should not preclude consideration for RPN.

Introduction

Obesity is associated with increased risk of renal cell carcinoma (RCC).^{1,2} With the obesity rate on the rise, it is likely that RCC will be diagnosed in more obese patients. A stan-

dard treatment modality for small renal masses is nephron-sparing surgery.^{3,4} Minimally invasive partial nephrectomy, both laparoscopic and robot-assisted, is an alternative to open partial nephrectomy, demonstrating comparable efficacy and oncologic control.⁵ A few single-institution studies have reported on outcomes of laparoscopic partial nephrectomy (LPN)^{6,7} and RPN⁸⁻¹¹ in obese patients; however, to the best of our knowledge, there are no large-scale, multicentre studies that evaluate the outcomes of RPN in obese patients. In this study, using data from five high-volume, academic centres, we report on the surgical outcomes of RPN in obese patients compared to non-obese patients.

Methods

Using a prospectively maintained, institutional review board (IRB)-approved database from five academic centres (Cleveland Clinic Foundation, Henry Ford Hospital, Johns Hopkins University, New York University, Washington University in St. Louis), we identified 1836 patients who underwent RPN from October 2006 to June 2014. All centres were high-volume, contributing similar numbers of patients. Patients were grouped into obese and non-obese cohorts. The obese cohort was defined as patients with BMI ≥ 30 kg/m². Morbid obesity was defined as BMI ≥ 40 kg/m². The non-obese cohort consisted of patients with BMI < 30 kg/m². All centres used the daVinci surgical system (Intuitive Surgical, Synnyvale, CA) for RPN and used similar surgical techniques.¹²

We compared demographic, preoperative, and perioperative variables between the two groups. We used the Mann Whitney U test for continuous variable and the Chi Square test for categorical variables. Demographic and preoperative variables included age, BMI, American Society of Anesthesiologists (ASA) score, Charlson comorbidity index (CCI), and RENAL nephrometry score. Perioperative factors included EBL, total operative time, intraoperative transfu-

sion, and WIT. Clavien classification system was used to categorize complications. Modification of Diet in Renal Disease equation was used to calculate estimated glomerular filtration rate (eGFR) and changes in eGFR were recorded from baseline to followup one to three months postoperatively, as previously described.¹⁰ We also compared pathological factors, which included tumour size and margin status. A subgroup analysis was done on the obese patients looking for the association of sex on outcomes of RPN. Multivariable linear regression models were used to assess the association of obesity and sex on the perioperative and postoperative outcomes, controlling for baseline patient and tumour characteristics. A 5% significance level was used for all tests and all analyses were performed using Statistical Package for the Social Sciences (SPSS), version 21 (IBM, Armonk, NY).

Results

A total of 1836 patients underwent RPN at five high-volume, academic centres. Of these patients, 806 (43.9%) were considered obese (BMI ≥ 30 kg/m²); within the obese group, 138 (17%) patients were morbidly obese (BMI ≥ 40 kg/m²). Table 1 summarizes baseline demographics and preoperative characteristics. The median BMI in the obese and non-obese groups were 33.8 kg/m² (31.6–38.0 kg/m²) and 26 kg/m² (23–28 kg/m²), respectively. Obese patients were younger (59 vs. 61, $p < 0.001$), yet had a higher ASA score (3 vs. 2, $p < 0.001$), tumour size (2.9 vs. 2.5 cm, $p < 0.001$), and RENAL nephrometry score (7.3 vs. 7.1, $p = 0.03$) than non-obese patients. The preoperative eGFR and CCI were similar between the two groups.

Table 2 summarizes the perioperative and postoperative outcomes for obese vs. non-obese patients. On univariate analysis, obese patients had a greater median operative time (176 vs. 165 min, $p = 0.002$) and median EBL (150 vs. 100 ml, $p = 0.002$), but this did not translate into a higher transfusion rate. There was no statistically significant difference between groups in WIT, change in eGFR, surgical margins, and intraoperative or postoperative complications. Most intraoperative complications involved intraoperative hemorrhage, but also included an enterotomy during lysis of adhesions (repaired robotically without sequelae) and a mesenteric hematoma during Veress needle placement. There were no conversions from RPN to open surgery. There were no conversions from RPN to open partial or robotic radical nephrectomy. Postoperative complications in the obese cohorts were medical in nature, except for one patient who had a urine leak.

Table 3 shows results of the multivariable linear regression analysis assessing the association of various preoperative parameters with RPN outcomes. Each regression coefficient (β) represents the change in the outcome variable (EBL, operative time, and WIT) per unit change in the predictor

Table 1. Demographic and preoperative patient characteristics for 1836 patients undergoing RPN at five academic centres stratified by obese (BMI ≥ 30 kg/m²) vs. non-obese (BMI < 30 kg/m²)

	Obese N=806 (43.9%)	Non-obese N=1030 (56.1%)	<i>p</i> value
Median BMI (IQR)	33.8 (31.6–38.0)	26 (23–28)	< 0.001
Median age (IQR)	59 (51–65)	61 (52–69)	< 0.001
Sex (%)			
Male	480 (59.6)	638 (62.9)	0.150
Female	326 (40.4)	377 (37.1)	
Median ASA score (IQR)	3 (2–3)	2 (2–3)	< 0.001
Age-adjusted CCI (IQR)	5 (3–6)	5 (3–6)	0.534
Median preoperative tumour size (cm, IQR)	2.9 (2.0–4.0)	2.5 (1.9–3.6)	< 0.001
Median preoperative eGFR (IQR)	83.5 (67.8–98.5)	83.3 (68.5–98.5)	0.982
Mean RENAL nephrometry score (SD)	7.3 (1.9)	7.1 (1.9)	0.003

ASA: American Society for Anesthesiologist; BMI: Body mass index; CCI: Charlson comorbidity index; eGFR: estimated glomerular filtration rate; IQR: Interquartile range; SD: Standard deviation.

variable (BMI, ASA score, age-adjusted CCI, tumour size, and nephrometry score). ASA score and age-adjusted CCI were independent predictors for operative time and EBL, respectively. Tumour size was an independent predictor for EBL, operative time, and WIT, whereas nephrometry score only predicted operative time and WIT. On multivariable linear regression, obesity was not an independent predictor of higher EBL or longer operative time.

A subset analysis of the obese cohort by sex showed that males had a lower median BMI (33 vs. 35, $p < 0.001$) compared to females, yet had significantly greater EBL (150 ml vs. 100 ml, $p < 0.001$), operative time (180 min vs. 166 min, $p < 0.001$), WIT (20 min vs. 18 min, $p = 0.001$), and major postoperative complications (4.8% vs. 3.1%, $p = 0.04$) (data not shown). On multivariable linear regression analysis among obese patients, male sex and tumour size independently predicted greater EBL, longer operative time, and WIT (Table 4). Similarly, morbid obesity and age-adjusted CCI served as independent predictors for EBL, while ASA score independently predicted operative time.

Discussion

Minimally invasive partial nephrectomy in obese patients may add technical challenges, including the need for possible longer trocars and limited mobility, and poor exposure of the kidney due to increased perinephric fat.¹¹ With the

Table 2. Postoperative outcomes for 1836 patients undergoing RPN at five academic centres stratified by obese (BMI ≥ 30 kg/m²) vs. non-obese (BMI < 30 kg/m²)

	Obese N=806 (43.9%)	Non-obese N=1030 (56.1%)	p value
Median operative time (min, IQR)	176 (142–212)	156 (135–203)	0.002
Median estimated blood loss (ml, IQR)	150 (100–250)	100 (75–200)	0.002
Median warm ischemia time (min, IQR)	19 (15–24)	19 (14–24)	0.278
Intraoperative complications (%)	16 (2.0)	20 (2.0)	0.985
Intraoperative transfusions (%)	30 (4.5)	35 (4.2)	0.755
Postoperative complication >Clavien grade 3 (%)	34 (4.4)	35 (3.5)	0.346
Positive surgical margin (%)	28 (3.5)	28 (2.8)	0.383
Median % change in eGFR (IQR)	-12.26 (-24.5–0.2)	-11.69 (-23.4–0.0)	0.417

eGFR: estimated glomerular filtration rate; IQR: Interquartile range.

prevalence of obesity increasing, it is important to assess the outcomes of minimally invasive surgery in this group of patients. There are a few small, single-institution studies that evaluated the association of obesity with laparoscopic and RPN outcomes;^{6–11, 13} however, to the best of our knowledge, there are no multicentre studies on this topic. Our study is the first large-scale, multicentre report on the association of obesity with RPN outcomes.

Several groups have reported on their experience with LPN in obese patients. Columbo et al⁷ compared 140 obese patients with 238 non-obese patients and found no statistically significant difference in mean EBL, operating time, WIT, hospital stay, and intraoperative or postoperative complication rates between obese and non-obese groups. Romero et al¹⁴ compared 56 obese and 56 non-obese patients who underwent LPN and found no difference in perioperative outcomes; however, obese patients had a higher median EBL (300 vs. 200 ml).

In a single-institution study, Naeem et al¹⁰ reported on outcomes of RPN in obese patients. Of the 97 patients who underwent RPN, a total of 49 were considered obese (BMI ≥ 30 kg/m²). Obese patients had higher EBL (150 vs. 100 ml), as well as a trend toward longer ischemia and operative time (26.5 vs. 22.5 min, 265 vs. 242.5 min, respectively), although these did not reach statistical significance. Isac et al¹¹ reported on 250 patients who underwent RPN, of which 103 patients were obese (BMI ≥ 30 kg/m²). Obesity was associated with higher ASA score (3 vs. 2), larger tumour size (2.9 vs. 2.3), and a higher EBL (200 vs. 150). There was no significant difference between the groups in terms of operative time, WIT, transfusion rate, and postoperative complications. Reynolds et al¹³ reported on 184 patients, of which 109 (59%) underwent LPN and 75 (41%) underwent RPN. Of the 184 patients who underwent minimally invasive partial nephrectomy, a total of 113 (61%) were obese. An increase in obesity was not associated with adverse perioperative and postoperative outcomes such as tumour size, ASA score, RENAL nephrometry score, EBL, operative time, WIT, transfusion rate, and complications.

Our study is the largest study evaluating the association of obesity with outcomes of RPN. Our cohort consisted of 44% obese subjects, which is similar to few single-institution studies, where obese subjects made up 40–50% of the total cohort.^{7–11} We found that obesity was associated with higher ASA score and operative time, consistent with the single-institution analysis by Isac et al.¹¹ Our study also showed that obesity was associated with higher EBL, consistent with studies by Naeem et al and Isac et al.^{10, 11} We did not see an increase in complications in obese patients, which is consistent with finding by Kiziloz et al.⁸

A unique finding of our study is that obesity was not an independent predictor of operative time and EBL on multivariable analysis. One possible explanation is that obese patients had a higher nephrometry score and tumour size, which is often associated with higher EBL and operative time, thus not providing additional information on the outcomes once these other variables are considered. Another unique aspect of our study is the subset analysis of the obese cohort, showing that male sex was an independent risk factor for increased EBL, operative time, and WIT. This

Table 3. Multivariable linear regression analysis for various predictors of EBL, operative time, and WIT for 1836 patients undergoing RPN

	Estimated blood loss		Operative time		Warm ischemia time	
	β (95% CI)	p value	β (95% CI)	p value	β (95% CI)	p value
BMI	1.2 (-0.07–2.64)	0.063	0.3 (-0.99–0.77)	0.131	-0.02 (-0.08–0.04)	0.472
ASA score	13.10 (-2.24–28.44)	0.094	12.82 (7.90–17.75)	<0.001	0.61 (-0.08–1.30)	0.081
Age-adjusted CCI	3.74 (0.162–7.32)	0.041	0.72 (-0.429–1.87)	<0.219	-0.14 (-0.30–0.02)	0.088
Tumour size	21.22 (15.25–27.20)	<0.001	7.68 (5.76–9.59)	<0.001	1.12 (0.85–1.38)	<0.001
Nephrometry score	3.61 (-1.17–8.41)	0.139	2.60 (1.07–4.13)	0.001	1.58 (1.37–1.80)	<0.001

ASA: American Society for Anesthesiologist; BMI: body mass index; CCI: Charlson comorbidity index; CI: confidence interval.

Table 4. Multivariable linear regression analysis for various predictors of EBL, operative time, and WIT for obese patients undergoing RPN

	Estimated blood loss		Operative time		Warm ischemia time	
	β (95% CI)	<i>p</i> value	β (95% CI)	<i>p</i> value	β (95% CI)	<i>p</i> value
Morbid obesity	49.88 (15.45–84.31)	0.005	7.71 (-3.36–18.77)	0.172	1.19 (-0.35–2.74)	0.131
ASA score	4.82 (-18.27–27.91)	0.682	14.91 (7.50–22.32)	<0.001	-0.04 (-1.08–1.01)	0.944
Male sex	30.90 (4.77–57.02)	0.021	21.43 (13.04–29.82)	<0.001	1.66 (0.47–2.84)	0.006
Age-adjusted CCI	7.14 (1.85–12.43)	0.008	1.12 (-0.58–2.82)	0.195	0.01 (-0.23–0.24)	0.968
Tumour size	23.63 (15.00–32.26)	<0.001	6.58 (3.80–9.37)	<0.001	0.86 (0.47–1.25)	<0.001
Nephrometry score	6.43 (-0.52–13.38)	0.070	2.63 (0.40–4.87)	0.021	1.66 (1.34–1.97)	<0.001

ASA: American Society for Anesthesiologist; CCI: Charlson comorbidity index; CI: confidence interval.

later finding could be attributed to the predominance of visceral fat in males, resulting in a difficult dissection and, subsequently, greater EBL, longer operative time, and WIT.¹⁴ While a few studies have already demonstrated feasibility of RPN in obese patients, these studies were smaller and single-institution in nature. The large and multi-institutional nature of our study gives it greater validity and generalizability.

This study is limited by its retrospective nature. The results of this study reflect the practices in high-volume, tertiary institutions. Consequently, results may not be reproducible in low-volume institutions. Our retrospective study design did not allow for assessment of perinephric fat thickness, which has been shown to be an independent predictor of operative complication during RPN

Conclusion

In our large, multicentre report on outcomes of RPN, obese patients had greater tumour size, RENAL nephrometry score, operating time, and EBL, but no increase in complications. On multivariable analysis, obesity was not an independent predictor of operative time or blood loss; however, among obese patients, male sex was an independent predictor of greater EBL, operative time, and WIT.

Competing interests: All authors declare no competing financial or personal interests.

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