Original Article

Feasibility of laparoscopic partial nephrectomy in the obese patient and assessment of predictors of perioperative outcomes

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Abstract

Introduction: Partial nephrectomy is the gold standard for treatment of small renal masses. Our study compares outcomes for obese (body mass index [BMI] ≥30) and healthy (BMI <30) patients undergoing laparoscopic partial nephrectomy (LPN) with the intention of defining preoperative risk factors for complications and renal insufficiency in the obese.

Materials and Methods: We conducted a retrospective review of 187 consecutive patients who underwent LPN. We examined the association between BMI and postoperative complication, estimated blood loss (EBL), hospital length of stay, warm ischemic time (WIT), and postoperative renal function. We did similar analyses using the RENAL nephrometry score and the comorbidity status of the patients.

Results: We found no statistically significant increase in complications in obese (BMI ≥30) individuals relative to healthy (BMI <30) patients. The obese experienced approximately 100 cc more EBL ($P = 0.0111$). Patients experienced more complications if they had a Charlson comorbidity score ≥3 ($P = 0.0065$), an American Association of Anesthesiologists score ≥3 ($P = 0.0042$), or a history of diabetes mellitus ($P = 0.0196$). There was no association between RENAL nephrometry score and complication. However, patients with a score ≥8 experienced higher WIT ($P = 0.0022$), a greater decline in estimated glomerular filtration rate postoperatively ($P = 0.0488$), and an increased risk of developing chronic kidney disease ≥3 ($P = 0.0065$).

Conclusions: Obese patients undergoing LPN are not at significantly increased risk of complication relative to nonobese patients. Comorbidity status and RENAL nephrometry score, independent of BMI, should be the main considerations of a patient's suitability for LPN.

Key Words: Laparoscopy, obesity, partial nephrectomy

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INTRODUCTION

Obesity has become increasingly prevalent in our society.[1] Not only has this resulted in increased health-related morbidity but also it has made treatment in these patients more challenging, particularly when dealing with minimally invasive surgery.[2]

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Of specific concern to urologists is the management of the small renal mass in the obese.[3] Nephron-sparing surgery is the gold standard for these small renal masses as a growing body of evidence has shown that leaving patients with a solitary kidney places them at increased risk of chronic kidney disease, increases their cardiovascular risk, and also increases the risk of overall mortality, often secondary to the aforementioned causes.[4]

Laparoscopic partial nephrectomy (LPN) is desirable to many patients because of the shorter associated hospital stay and better cosmetic results, combined with equivocal oncologic outcomes when compared to open partial nephrectomy (OPN), especially for early stage (T1) disease.[5-10] However, only a limited number of studies exist examining the safety and efficacy of LPN in obese patients.[11-17] A 2012 meta-analysis concluded that LPN is safe and feasible in the obese population but that there was an increased risk of major complications.[11] A number of recent studies have also drawn similar conclusions regarding the feasibility of LPN.[12,13]

The objective of this study was to determine whether body habitus contributes to postoperative complication risk as well as postoperative renal functional decline. In addition, we examined how comorbidity and RENAL nephrometry score[18] affect these outcomes.

MATERIALS AND METHODS

After receiving ethics approval, a retrospective chart review was conducted of all patients undergoing LPN under the care of three experienced surgeons at two tertiary care centers between January 2011 and May 2015. Imaging analysis using the RENAL nephrometry score[18] was conducted independently by two urologists, where there was discord, scans were reviewed, and consensus reached. All estimated glomerular filtration rate (eGFR) values were calculated from serum creatinine values using the chronic kidney disease epidemiology collaboration (CKD-EPI) equation.[19] New-onset Stage III CKD was defined as any calculated eGFR <60 within 1 year of surgery when preoperative eGFR ≥60.

Patients whose body mass index (BMI) was between 30.0 kg/m^2 and 34.9 kg/m^2 were classified as being obese; those with a BMI between 35.0 kg/m^2 and 39.9 kg/m^2 as morbidly obese; and those >40.0 kg/m^2 as super obese;[20] for comparison and simplicity, patients with a BMI <30.0 were classified as healthy. Complications were classified according to a version of the Clavien-Dindo system modified for nephrectomy patients.[21,22] A bleeding complication was defined as one which necessitated either blood transfusion or independent surgical exploration. The Charlson comorbidity index (CCI)[23] and the American Society of Anesthesiologists (ASA) score[24] were used to assess a patient's comorbid status.

The Fisher-exact test or Student's *t*-test were used for assessing relationships between categorical or continuous variables, respectively. All tests were two-sided and significance was defined as $P \leq 0.05$.

RESULTS

One hundred and eighty-seven patients met the criteria for inclusion in the study. Mean tumor size was 3.22 cm. Obese patients (BMI >30) had a larger mean tumor size than the healthy (3.42 cm vs. 2.97 cm; $P = 0.0112$). Superobese patients (BMI ≥40) tended to be younger and have a higher ASA score. Obese patients were more likely to be diabetic; however, there was no significant difference in CCI or RENAL nephrometry score between any of the subgroups. These data are summarized in Table 1.

Twenty-eight patients (15%) experienced a total of 35 complications. Of these, two (1.1%) experienced a urine leak, nine (4.8%) experienced a bleeding complication, and twelve (6.4%) experienced a complication of Clavien-Dindo Grade 3 or higher. One super obese patient died 5 weeks postoperatively due to bilateral pulmonary emboli. One patient was converted intraoperatively from LPN to OPN due to a prohibitive amount of intraabdominal and perivisceral fat. Two patients were converted from LPN to laparoscopic radical nephrectomy; one was due to the inability to obtain adequate resection margins and the other was experiencing a ST segment elevation myocardial infarction intraoperatively. These were not included as complications. Two patients developed incisional hernias postoperatively that required subsequent repair.

As a group, obese patients (BMI ≥30) were more likely to have greater blood loss (261 cc vs. 162 cc; $P = 0.0111$) and longer length of stay (4.11 d vs. 3.29 d; $P = 0.0185$). Although not statistically more likely to have increased complications, those with BMI ≥30 trended toward increased complications (20% vs. 9%, $P = 0.064$) and the morbidly obese group in particular was more likely to have complications ($P = 0.0243$) [Table 2].

Comorbidities were strong predictors of complication in LPN patients. Patients whose CCI ≥3 experienced significantly more complications than healthier patients whose CCI <3 ($P = 0.0065$). Similarly, patients with an ASA ≥3 experienced more complications than those whose ASA <3 ($P = 0.0042$). In addition, diabetic patients experienced more complications than nondiabetic patients ($P = 0.0196$). Charlson score, but not ASA score, was also predictive of Clavien-Dindo Grade 3 complication ($P = 0.0326$) [Table 2]. Notably, RENAL nephrometry score did not predict increased risk of complication, estimated blood loss (EBL), or LOS.

Table 1: Clinical and perioperative characteristics of patients undergoing laparoscopic partial nephrectomy, stratified by body mass index

BMI	<30 (*n*=85)	≥30 (*n*=102)	30-34.9 (*n*=58)	35-39.9 (*n*=28)	≥40 (*n*=16)
Tumor size (cm), $\bar{\chi}$ (SD)	2.97 (1.1)	**3.42 (1.4)** **P=0.0171**	3.27 (1.2) P=0.1324	**3.73 (1.7)** **P=0.0361**	3.41 (1.3) P=0.2981
Age, $\bar{\chi}$(SD)	59.72 (9.6)	**56.20 (11.8)** **P=0.0257**	57.48 (12.6) P=0.2539	55.07 (11.6) P=0.0630	**53.50 (8.8)** **P=0.0181**
Sex (male:female)	53:32	61:41 P=0.7645	38:20 P=0.7266	17:11 P=0.8769	6:10 P=0.0643
Charlson score, $\bar{\chi}$ (SD)	2.46 (1.6)	2.28 (1.6) P=0.4546	2.38 (1.7) P=0.7813	2.29 (1.7) P=0.8463	1.94 (1.2) P=0.1577
ASA score, $\bar{\chi}$ (SD)	2.21 (0.6)	2.28 (0.6) P=0.4111	2.21 (0.6) P=1.000	2.25 (0.5) P=0.7306	**2.63 (0.5)** **P=0.0061**
Diabetes history	10	**30** **P=0.004**	**15** **P=0.0425**	**10** **P=0.0083**	**5** **P=0.0444**
Mean preoperative eGFR (ml/min/1.73 m2), $\bar{\chi}$ (SD)	81.98 (26.20) *n*=61	**93.92 (32.77)** ***n*=63** **P=0.0271**	93.25 (36.93) *n*=36 P=0.0829	94.00 (27.42) *n*=19 P=0.0881	96.75 (27.35) *n*=8 P=0.1403
Mean postoperative eGFR (ml/min/1.73 m2), $\bar{\chi}$ (SD)	70.15 (23.28) *n*=61	78.94 (29.39) *n*=63 P=0.0679	79 (33.07) *n*=36 P=0.1263	75.21 (22.96) *n*=19 P=0.4091	87.50 (26.61) n=8 P=0.0552

Statistically significant results are in bold. Obese patients tended to have larger tumors, were on average older, and were more likely to have diabetes. SD: Standard deviation, ASA: American Society of Anesthesiologists, eGFR: Estimated glomerular filtration rates, BMI: Body mass index

Table 2: Surgical outcomes for laparoscopic partial nephrectomy, stratified by body mass index

BMI	<30 (*n*=85)	≥30 (*n*=102)	30-34.9 (*n*=58)	35–39.9 (*n*=28)	≥40 (*n*=16)
Complications	8	20 P=0.0642	10 P=0.2023	**8** **P=0.0243**	2 P=0.6471
Complications, ≥Grade 3	3	9 P=0.2300	5 P=0.2699	3 P=0.1605	1 P=0.5041
Mean EBL (cc), $\bar{\chi}$ (SD)	162.5 (212.1)	**261 (306.0)** **P=0.0111**	233.9 (302.5) P=0.1288	**324.1 (344.6)** **P=0.0279**	253.3 (240.9) P=0.1878
Mean hospital LOS (days), $\bar{\chi}$ (SD)	3.29 (1.35)	**4.1 (2.9)** **P=0.0198**	**4.0 (2.2)** **P=0.041**	4.73 (4.3) P=0.104	3.29 (1.3) P=1.00
WIT (min)	26.14 (10.2)	27.24 (13.4) P=0.5520	26.40 (13.6) P=0.9098	28.96 (13.3) P=0.3400	27.44 (13.4) P=0.7184
Nephrometry score, $\bar{\chi}$ (SD)	6.77 (1.7)	7.06 (1.8) P=0.2651	6.83 (1.7) P=0.8410	7.52 (1.9) P=0.8410	7.13 (1.7) P=0.4647

Statistically significant results are in bold. Obese patients did not experience significantly more complications but did experience greater estimated blood loss and hospital LOS. SD: Standard deviation, BMI: Body mass index, EBL: Estimated blood loss, LOS: Length of stay, WIT: warm ischemic time

When examining postoperative renal function, 15 patients (15%) experienced new-onset CKD ≥3 within 1 year of surgery. While there was no statistically significant difference in the change of eGFR in the obese group overall (BMI ≥30) relative to healthy patients, the morbidly obese group alone had a statistically significant increase in decline of their eGFR; no group was more likely to develop new-onset CKD ≥3. Patients whose tumors had high RENAL nephrometry (≥8) experienced, on average, 6 min longer warm ischemic time (WIT) ($P = 0.0024$). In addition, these patients had a greater decline in eGFR postoperatively ($P = 0.0480$) and an increased risk of new-onset CKD ≥3 ($P = 0.0065$) [Table 3].

DISCUSSION

Our conclusions are in general concordance with previous studies. Two studies in 2012 and 2013 concluded that LPN is safe in obese patients.[12,13] A 2014 study found that increasing BMI was not associated with adverse perioperative outcomes for LPN and that increasing nephrometry score was the only predictor of complications with LPN.[14] Most recently, a 2015 study found decreased blood loss for LPN relative to OPN in obese patients, with no difference in hospital length of stay.[15]

Our work has shown no significant difference in risk of complication between obese and nonobese individuals undergoing LPN in general. In addition, our results show that there was no increased risk of Grade 3 complications; this contrasts with the results of a 2012 meta-analysis that showed increased risk of major complications.[11] There was no increased risk of induction of CKD ≥3 with LPN in the obese. The only negative perioperative outcome for which obese patients were at risk was increased EBL, and this did not result in any tangible increase in morbidity. As such, these

Table 3: Postoperative changes in renal function grouped by nephrometry score

Nephrometry score	<8 (*n*=80)	≥8 (*n*=43)	Significance (*P*)
Preoperative eGFR (ml/min/1.73 m²), $\bar{\chi}$(SD)	**92.09 (33.1)**	**80.37 (22.8)**	**0.0405**
Postoperative eGFR (ml/min/1.73 m²), $\bar{\chi}$ (SD)	**81.33 (28.3)**	**62.19 (19.0)**	**0.0001**
Change in eGFR (ml/min/1.73 m²), $\bar{\chi}$ (SD)	**−9.86 (16.0)**	**−16.23 (16.7)**	**0.04801**
Warm ischemic time (min)	**27.5 (10.7)**	**33.5 (8.4)**	**0.0024**
New-onset CKD ≥3	**5 (*n*=64*)**	**10 (*n*=33*)**	**0.0065**

*Patients who had CKD ≥3 preoperatively were excluded. Statistically significant results are in bold. Patients with more complex tumors had a longer WIT, a larger drop in eGFR postoperatively, and were more likely to develop CKD ≥3 postoperatively. WIT: warm ischemic time, CKD: Chronic kidney disease, eGFR: Estimated glomerular filtration rates, SD: Standard deviation

results lend further support to the claim that LPN is indeed safe in obese patients.

Patients whose ASA and Charlson scores ≥3 had, not surprisingly, a significantly higher risk of complication. In addition, a history of diabetes predicted higher risk. These results support the conclusion that comorbidity status is a more important factor than BMI when predicting perioperative risk in LPN. Of note, the increased risk of complications in diabetics, as well as the increased prevalence of diabetes in the obese, could explain the statistically nonsignificant trend towards more complications observed in our obese cohort.

Morbidly obese patients did experience an increased postoperative decline in eGFR. The cause for this is unclear as mean WIT was not increased in obese patients. It is possible that the increased incidence of diabetes in the obese contributed to the increased risk of postoperative decline in renal function. Further studies are needed to fully elucidate the pathology of the perioperative renal risk in this population.

Increased RENAL nephrometry score was predictive of increased WIT, greater decline in eGFR, and increased risk of CKD ≥ 3 postoperatively. This is an intriguing hint that the increased difficulty of dissection of tumors with high nephrometry score, and the consequently increased WIT, contributes to permanent renal parenchymal damage. Further study will be needed to elucidate if certain components of the RENAL score play a greater contributing role in this relationship as well as its clinical significance.

Taken together, these results argue for the conclusion that body habitus should not preclude minimally invasive PN when it is otherwise desirable. In addition, we conclude that when considering a patient's suitability for LPN, comorbidity should be a primary consideration independent of BMI. Finally, our finding that WIT is increased in patients with complex tumors should mandate some caution when considering LPN in these patients, and prompt increased consideration of an open approach.

This study is susceptible to the limitations inherent with retrospective studies. In addition, the lack of inclusion of robotic LPN patients precludes generalization of these results to minimally invasive nephrectomy in general beyond traditional LPN.

Compared to previous studies, we believe our series is unique because, to our knowledge, it is the only study of LPN in the obese that has also considered comorbidities, RENAL nephrometry score as well as postoperative renal functional outcomes. The only comparable series to date was comprised heterogeneous robotic and laparoscopic partial nephrectomies; robotic nephrectomy was used in this series for the more complex tumors, thus precluding analysis of LPN in complex tumors.[14] In addition, that study did not include analysis of renal function and was limited by a smaller mean tumor size of 2.6 cm in their laparoscopic group. We, therefore, believe that ours is one of the most comprehensive studies of LPN in the obese to date.

CONCLUSIONS

LPN is safe in obese patients, is not associated with increased WIT, and does not increase the risk of development of new-onset CKD ≥3. Obese patients experience, on average, increased blood loss during surgery. Preoperative comorbidity status is an important predictor of risk of complication in LPN patients. In addition, increased RENAL nephrometry score predicted increased postoperative decline in eGFR and new-onset CKD ≥3; this is associated with an increase in renal WIT. We, therefore, conclude that comorbidity and tumor complexity, independent of BMI, should be the main considerations of a patient's suitability for LPN.

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Conflicts of interest
There are no conflicts of interest.

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