

# Laparoscopic and Open Partial Nephrectomy: Complication Comparison Using the Clavien System

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## ABSTRACT

**Background and Objectives:** To compare postoperative complications in patients undergoing laparoscopic and open partial nephrectomy using a standardized complication-reporting system and a standardized tumor-scoring system.

**Methods:** We conducted a retrospective analysis of 189 consecutive patients with nephrometry scores available who underwent elective partial nephrectomy for renal masses. Demographic, perioperative, and complication data were recorded. By using the modified Clavien scale, we graded 30- and 90-day complication rates.

**Results:** 107 patients underwent laparoscopic partial nephrectomy and 82 underwent open partial nephrectomy (N=189). Open partial nephrectomy patients had higher nephrometry scores than laparoscopic patients had ( $7.1 \pm 2.4$  vs.  $5.6 \pm 1.8$ ,  $P < .001$ ). Surgical and hospitalization times were shorter, and estimated blood loss was lower in the laparoscopic group ( $P < .001$ ). At 30 days, there were more overall complications in the open group, but more major complications in the laparoscopic group ( $P > .05$ ). After multivariable logistic regression analysis, only higher body mass index and higher estimated blood loss were predictors of more overall complications.

**Conclusions:** Laparoscopic partial nephrectomy has the advantages of decreased operative time, lower blood loss, and shorter hospital stay. The complication rate in the laparoscopic group is similar to that in the open group, despite favorable tumor characteristics in the laparoscopic group.

**Key Words:** Minimally invasive surgery, Kidney neoplasm, Kidney surgery.

## INTRODUCTION

Laparoscopic partial nephrectomy (LPN) has been increasingly performed for select small renal masses, because it has been shown to provide similar oncologic outcomes to that of open partial nephrectomy (OPN).<sup>1,2</sup> However, LPN is a technically challenging procedure. Even in expert hands, this procedure has been shown to have a potentially high complication rate.<sup>3</sup> Specifically, bleeding requiring transfusion, urinary leakage, and positive margins are some of the most concerning complications.<sup>4</sup> Also, the need for clamping of the hilum has raised the issue of possible renal injury related to the warm ischemia.<sup>5</sup> Conversely, many OPN series<sup>6,7</sup> that reported more complications were representative of higher risk groups, as defined by greater age, increased comorbidities and symptoms, decreased renal function, and poorer tumor characteristics (size and depth).

Some institutions have recently begun systematically recording complication data for renal cancer surgery.<sup>8-10</sup> However, these studies are limited by differences among the groups due to variability in the anatomic relationship of the tumors with the kidney anatomy. The Preoperative Aspects and Dimensions Used for an Anatomical (PADUA) scoring system has been used to evaluate complications in patients undergoing OPN.<sup>11</sup> We compared renal tumors using another objective renal mass scoring system (nephrometry)<sup>12</sup> to characterize and objectify the complexities of the lesions resected in both of our groups. Using the modified Clavien classification system<sup>13</sup> of surgical complications, we report our 30- and 90-day complication rates after OPN and LPN at a single institution.

## PATIENTS AND METHODS

The records of all patients undergoing partial nephrectomy at our institution were reviewed after institutional review board approval. All procedures were performed by 2 (1 laparoscopic and 1 open) surgeons from January 2000 to December 2009. All nephrectomies performed at our institution during the specified time period were recorded in our database, and selection criteria for this study were applied after all data were collected. Selection criteria for nephron-sparing surgery were based on preoperative CT

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scan, localization/accessibility of the tumor, and the general health status of the individual patient, as well as individual surgeon preferences. Clinical and pathologic parameters, including age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) score, estimated blood loss (EBL), nephrometry score,<sup>12</sup> operative time (from skin opening to closing), length of stay, pathologic stage, and surgical margin status, were retrospectively collected from hospital and outpatient electronic medical records as well as correspondence from physicians outside our institution. Thirty- and 90-day complications were collected. We limited our analysis to 90 days, assuming that most peri-operative complications will occur within that time frame. Correspondence with patients and their physicians ensured that treatment received outside of our institution or in the office setting was accounted for in our database. Hospital and outpatient electronic medical records, as well as correspondence from physicians outside our institution, were combed for any deviation from the normal postoperative course, and all deviations were recorded in our database. All complications were then carefully graded using the modified Clavien system<sup>13</sup> and were additionally classified by organ system. The work of cataloguing complications and applying the standardized grading criteria was done by 3 individuals, who studied each patient's chart and read through all sections to gather data on patient and tumor characteristics as well as postoperative course. Similarly, the work of calculating nephrometry score was done by 2 individuals working directly with imaging from the institution's radiology system. Grades 1 and 2 complications were classified as minor, and grades 3 through 5 were classified as major. Bleeding was defined by transfusion with  $\geq 1$  unit of packed red blood cells.

The surgical techniques of LPN and OPN were similar and have been described previously.<sup>14</sup> Briefly, during LPN, bulldog clamps were used for arterial clamping. Venous occlusion was performed at the surgeon's discretion. The tumor was excised with round-tipped scissors. Collecting system defects were repaired with intracorporeal suturing. The base of the resection was biopsied and then coagulated with an argon beam coagulator. Renal parenchymal reconstruction was performed with a combination of suturing large vessels with 3/0 and 4/0 braided absorbable sutures, argon-beam coagulation, and adjunctive hemostatic agents, including Gelfoam (Pfizer, New York, NY, USA), Surgicel (Johnson and Johnson, New Brunswick, NJ, USA) and Bioglue (Cryolife Inc., Kennesaw, GA, USA). Tumor size is reported as the longest single dimension of the lesion as measured by the pathologist. Pathological

staging was performed according to the 2002 International Union Against Cancer (UICC)/American Joint Committee on Cancer tumor-node-metastasis (TNM) staging system.

Statistical analysis was performed using Pearson's  $\chi^2$  test and the Fisher exact test to compare categorical variables, and the Student *t* test for comparison of continuous variables. Univariate and multivariable logistic regression analyses were performed to identify variables predictive of overall complications. Variables reaching or approaching statistical significance on univariate analysis, as defined by  $P < .05$  and  $P < .10$ , respectively, were included in a multivariable logistic regression analysis to identify independent risk factors for overall complications. Statistical analyses were performed using the Statistical Package for the Social Sciences 16.0 (SPSS, Chicago, IL, USA), with a 2-sided,  $P < .05$  considered to indicate statistical significance.

## RESULTS

Between January 2000 and December 2009, 364 patients underwent partial nephrectomy. Of these patients, nephrometry data were available for 107 patients who underwent LPN and 82 who underwent OPN. A comparison of baseline preoperative characteristics between OPN and LPN patients is shown in **Table 1**. Patients in the OPN group had larger tumors and higher nephrometry scores than LPN patients had ( $P < .001$ ). Mean operative time was longer in the OPN group ( $P < .001$ ). The LPN group demonstrated lower blood loss and shorter length of stay ( $P < .001$ ). There was no significant difference in age, sex, ASA score, laterality, or location of the tumor between the 2 groups. There was also no significant difference in the rate of benign and malignant tumors between the 2 groups.

At 30 days, no statistically significant difference was noted in the overall complications between the OPN and LPN groups (29% vs. 17%; **Table 2**). Of those who had complications, LPN patients had more major complications (grades 3 through 5) compared to the OPN group, but this difference did not reach statistical significance. Although the total number of LPNs increased over time, the total number of overall complications did not increase per year during the study period. Between 2000 and 2004, in the LPN group 7 patients had complications, while 12 patients had complications between 2005 and 2009. Similarly, in the OPN group, 10 patients had complications during the earlier time period (2000 through 2004), while 14 patients had complications in the more recent cohort (2005 through 2009); the differences between rates in both groups over time were not statistically significant.

**Table 1.**  
Baseline Characteristics of Patients Undergoing Laparoscopic and Open Partial Nephrectomy

<b>Patient Characteristics<sup>a</sup></b>	<b>Laparoscopic</b>	<b>Open</b>	<b>P Value</b>
Total no. patients	107	82	
Mean age (range)	62 (24–86)	62 (34–84)	.9
Sex (male: female), %	69:38 (64:35)	59:23 (72:28)	.4
Mean ASA Score (range)	2.2 (1–4)	2.3 (1–4)	.2
Mean total operative time, hrs (range)	2.6 (0.8–5.5)	3.3 (1–5.5)	<.0001
Mean hospitalization, d (range)	2.6 (1–23)	5.0 (2–15)	<.0001
Mean estimated blood loss, mL	240	457	.0002
<b>Tumor Characteristics</b>			
Mean tumor size, cm (range)	2.6 (0.2–7.8)	3.1 (0.3–8.5)	.02
Laterality (right: left), %	62:45 (58:42)	46:36 (56:44)	.9
Location, %			
Upper Segment	34.7	36.1	.9
Middle Segment	18.8	24.0	.5
Lower Segment	46.2	40.0	.9
Nephrometry Score			
Low (4–6), %	69.2	35.4	<.0001
Medium (7–9), %	29.0	46.3	.02
High (10–12), %	1.9	18.3	.0001
Hilar designation, %	2.8	6.1	.3
Endophytic Score $\geq 2$ , %	29.0	62.2	.0001
Nearness score $\geq 2$ , %	35.5	69.5	.0001
Pathologic diagnosis, %			
Benign	17.8	18.3	.2
Malignancies-RCC	46.7	41.5	.2
Clear Cell	17.8	18.3	
Papillary	17.8	22.0	
Other	10.3	18.3	

<sup>a</sup>ASA = American Society of Anesthesiologists, d = days, hrs = hours, no. = number, RCC = renal cell carcinoma.

**Table 2.**  
Complications After Laparoscopic and Open Partial Nephrectomy Classified Using the Modified Clavien System

	<b>Laparoscopic</b>	<b>Open</b>	<b>P Value</b>
<b>No. Patients with Complications (% total)</b>	19 (17.8%)	24 (29.3%)	.1
No. 30-day	19 (17.8%)	22 (26.8%)	.2
No. Grade 3–5	8 (7.5%)	3 (3.7%)	.08
No. 90-day	2 (1.9%)	2 (2.4%)	1.0
No. Grade 3–5	0	0	1.0

As shown in **Table 3**, bleeding that required transfusion was the most common complication in the OPN group (45%), followed by genitourinary (16%) and wound-related (13%) complications. In the LPN group, bleeding

complications were again the most common (23%). However, urinary complications were also quite common (23%), followed by infections (15%). The overall transfusion (intraoperative and postoperative) rate in the LPN

**Table 3.**  
Complications of Open and Laparoscopic Nephron-sparing Surgery Classified by Organ System

Category <sup>a</sup>	Laparoscopic	Open	P Value
<b>Gastrointestinal, no. (%)</b>	3 (12)	2 (6)	.7
<i>Clostridium difficile</i> Infection	1		1
Ogilvie Syndrome	0	1	
Ileus	1	0	
Gastrointestinal Bleeding	1		0
<b>Wound, no. (%)</b>	2 (8)	4 (13)	.7
Wound Infection	1	4	
Incisional Hernia	1	0	
<b>Infectious Disease, no. (%)</b>	4 (15)	2 (6)	.7
UTI	2	0	
Sepsis	1	1	
Perirenal abscess	1	0	
Pneumonia	0	1	
<b>Cardiac, no. (%)</b>	2 (8)	1 (3)	.6
NSTEMI	1	1	
Atrial Fibrillation	1	0	
<b>Genitourinary, no. (%)</b>	6 (23)	5 (16)	.5
Renal Failure	1	1	
Urinary Fistula	4	1	.2
Urinary Retention	1	0	
Hematuria	0	3	
<b>Thromboembolic, no. (%)</b>	2 (8)	1 (3)	.6
Pulmonary Embolism	0	1	
DVT	2	0	
<b>Pulmonary, no. (%)</b>	1 (4)	1 (3)	1
Respiratory Failure	0	0	
Atelectasis	0	1	
Pleural Effusion	1	0	
<b>Bleeding requiring transfusion (%)</b>	6 (23)	14 (45)	.1
Intra-operative	5	6	
Postoperative	1	8	
<b>Miscellaneous, no. (%)</b>	0 (0)	1 (3)	1
Death	0	1	

<sup>a</sup>ASA=American Society of Anesthesiologists, DVT=deep vein thrombosis, no.=number, NSTEMI=non-ST elevation myocardial infarction, UTI=urinary tract infection.

group was 6% and 19% in the OPN group ( $P < .001$ ). The postoperative transfusion rate was 0.9% in the LPN group and 10% in the OPN group.

Of the 3 patients in the OPN group who had a major complication (grades 3 through 5), 1 patient died (grade 5) from pulmonary embolism leading to sepsis and multi-organ dysfunction syndrome. One patient had Ogilvie's syndrome (acute colonic pseudo-obstruction) and needed intensive care unit (ICU) admission (grade 4). The third patient needed a ureteral stent (grade 3) for a urinary leak; the stent was removed after the leak resolved.

Of the 8 patients in the LPN group who had major complications, 2 required ICU admission (grade 4). One patient had a non-ST-elevation myocardial infarction (NSTEMI) and congestive heart failure, while the other had an upper gastrointestinal bleed. The remaining 6 patients underwent additional procedures (grade 3). Four patients in the LPN group who had urinary leaks required ureteral stent placement (grade 3a), and 1 underwent hemicolectomy due to a nephrocolonic fistula (grade 3b). One patient underwent cardioversion for atrial fibrillation (grade 3a). Ninety-day complications (grades 1 and 2) in the LPN group were *P. aeruginosa* and *E. coli* UTI, whereas OPN complications were wound infection and hematuria. Using multivariable analysis, we found that higher BMI and higher EBL predicted more overall complications (**Table 4**). There were no predictors of major complications.

## DISCUSSION

LPN has been shown to be a technically feasible alternative to OPN with similar surgical efficacy.<sup>15,16</sup> When compared with OPN, LPN was associated with a higher rate of complications in several early studies,<sup>6,17</sup> but similar complication rates have been reported in more recent studies.<sup>1,2,18</sup> Although a comparison of OPN vs. LPN has been reported in the literature,<sup>2,7</sup> there are relatively few studies<sup>8-10</sup> that use an objective and standardized system to record and categorize peri-operative complications. We used the modified Clavien system<sup>13</sup> to standardize and compare complications, because this allows for an objective assessment of changes in technique as well as an improved comparison of newer treatment strategies. Furthermore, we utilized the nephrometry scoring system<sup>12</sup> to standardize and compare renal tumors between the 2 cohorts. Our results are generalizable due to the standardized nature of our data, both with respect to grading complication severity and assessing tumor complexity.

Predictor	Univariate Analysis	
	OR (95% CI)	P Value
Gender (F vs. M)	0.719 (0.333–1.553)	.401
Age	1.027 (0.997–1.058)	.079
BMI <sup>a</sup>	1.072 (1.005–1.142)	.034
Laparoscopic vs. Open	0.589 (0.294–1.181)	.136
ASA <sup>a</sup>	2.492 (1.341–4.628)	.004
EBL <sup>a</sup>	1.002 (1.001–1.003)	<.001
Tumor Size	1.258 (1.017–1.557)	.034
Nephrometry Score	1.084 (0.919–1.278)	.337
Nephrometry Score (Low 4-6 vs. High 10-12)	0.442 (0.146–1.338)	.148
Nephrometry Score (Medium 7-9 vs. High 10-12)	0.509 (0.162–1.604)	.249
Renal size (1 vs. $\geq 2$ )	0.723 (0.307–1.700)	.457
Exophytic (1 vs. $\geq 2$ )	0.470 (0.232–0.948)	.035
Near to collecting system (1 vs. $\geq 2$ )	1.079 (0.540–2.155)	.83
Location relative to polar line (1 vs. $\geq 2$ )	0.640 (0.316–1.296)	.215
	Multivariable Analysis <sup>b</sup>	
	OR (95% CI)	P value
Age	1.025 (0.984–1.067)	.24
BMI <sup>a</sup>	1.092 (1.010–1.179)	.027
ASA <sup>a</sup>	1.591 (0.730–3.471)	.243
EBL <sup>a</sup>	1.002 (1.001–1.003)	.001
Tumor Size	1.120 (0.871–1.440)	.376
Exophytic (1 vs. $>2$ )	0.756 (0.337–1.696)	.497

<sup>a</sup>ASA=American Society of Anesthesiologists, BMI=body mass index, EBL=estimated blood loss, no.=number.

<sup>b</sup>Association of preoperative and operative variables with occurrence of 30-day complication. Variables that were significant ( $P < .05$ ) or near significant ( $P < .10$ ) were included in the multivariable analysis.

Despite favorable preoperative tumor characteristics, lower EBL, and shorter hospital stay in the laparoscopic group, there were more major complications (grades 3 through 5) with LPN (6.2%) compared with OPN (3%). This difference did not reach statistical significance. When we analyzed the entire cohort of 364 patients, there were more major com-

plications in the LPN group, and this difference was statistically significant. This is in accordance with the recently published guidelines on the management of clinical stage 1 renal mass.<sup>19</sup> In the metaanalysis, the authors concluded that LPN was associated with a higher major urologic complication rate than OPN was (9% vs. 6.3%).

There was a higher urinary leak rate in the LPN group, likely due to the technical difficulties associated with intracorporeal suturing. We considered that this might have been due to a higher complexity of the lesions; however, of the 5 of the 6 patients who had a urinary fistula in the LPN group, the average nephrometry score was 5 (one patient had a score of 9). Nephrometry scores were available for 107 out of the 176 LPN patients, and therefore there may be some inherent selection bias. In a multi-institutional review of 1800 laparoscopic and open partial nephrectomies, Gill et al<sup>7</sup> reported a 3.1% urinary leak rate for laparoscopic partial nephrectomy; we experienced a 3.4% leak rate with our LPN group. Additionally in the same series, the number of patients who required 1 or more postoperative blood transfusions was 45 in the LPN group (5.8%) and 35 in the OPN group (3.4%). Our bleeding complications in the LPN group compare favorably (2.8%) but were much higher in the OPN group (12%).

Prior studies have published complication data for 30 days. Though we collected complication data for 90 days, we found that the majority of the complications happened within 30 days. This is in contrast to the bladder cancer literature where there are almost an equal percentage of complications between 30 and 90 days.<sup>20</sup>

Nephrometry,<sup>12</sup> Padua,<sup>11</sup> and C-index scores<sup>21</sup> are recent methods to standardize and compare renal tumors. To our knowledge, this is the first study to incorporate the nephrometry scoring system, a standardized system to compare the anatomic relationship of the tumors with the kidney anatomy to compare patients who underwent LPN and OPN. One study has been published using nephrometry score to evaluate outcomes with robot-assisted LPN.<sup>22</sup> Though mean tumor size and the general tumor location have been reported in previous studies,<sup>7,9,15</sup> there was no assessment of tumor complexity. In our study, which does include a standardized assessment of tumor complexity, the LPN group had favorable characteristics compared to the OPN group in that it had lower nephrometry scores, lower EBL, and shorter hospital stay, but despite all these apparent advantages still failed to show a decreased rate of complications.

We recognize several important limitations to our study. We recognize the retrospective nature of this study as well as its

limited sample size due to our restriction of the data analysis to patients with nephrometry scores available. This may have led to selection bias, and also reduced the statistical power of our study. The retrospective nature of the study means that our LPN and OPN groups have significantly different tumor complexities as measured by nephrometry score. Another limitation is the lack of clamp times for the LPN group. We were unable to study changes in renal function in the postoperative setting due to this missing variable, a factor that could have contributed to postoperative complication rates in the LPN group. In addition, our study is limited by the volume of LPN and OPN cases over time, since LPN is a newer procedure and volume has increased over time. In spite of this, there was no difference in complication rates between the earlier and later cohorts.

## CONCLUSION

Overall, we conclude that although laparoscopic partial nephrectomy has the advantages of decreased operative time, lower blood loss, and a shorter hospital stay, there is no significant difference in complication rates between laparoscopic partial nephrectomy and open partial nephrectomy. Furthermore, LPN and OPN in our study resulted in similar complication rates despite favorable tumor characteristics in patients undergoing laparoscopic partial nephrectomy. That is, in spite of the selection of tumors with lower objective complexity for laparoscopic partial nephrectomy, the complication rate in the laparoscopic group was not lower than it was in the open partial nephrectomy group. We believe that appropriate understanding of the complexity of the lesion, possible complications, and management techniques is essential in reducing the risk of complications, in appropriately counseling the patient, and in choosing between the laparoscopic and open approaches.

## References:

1. Breda A, Stepanian SV, Liao J, et al. Positive margins in laparoscopic partial nephrectomy in 855 cases: a multi-institutional survey from the United States and Europe. *J Urol.* 2007; 178(1):47–50, discussion 50.
2. Marszalek M, Meixl H, Polajnar M, Rauchenwald M, Jeschke K, Madersbacher S. Laparoscopic and open partial nephrectomy: a matched-pair comparison of 200 patients. *Eur Urol.* 2009;55(5): 1171–1178.
3. Ramani AP, Desai MM, Steinberg AP, et al. Complications of laparoscopic partial nephrectomy in 200 cases. *J Urol.* 2005; 173(1):42–47.

4. Gill IS, Matin SF, Desai MM, et al. Comparative analysis of laparoscopic versus open partial nephrectomy for renal tumors in 200 patients. *J Urol.* 2003;170(1):64–68.
5. Janetschek G. Laparoscopic partial nephrectomy: how far have we gone? *Curr Opin Urol.* 2007;17(5):316–321.
6. Polascik TJ, Pound CR, Meng MV, Partin AW, Marshall FF. Partial nephrectomy: technique, complications and pathological findings. *J Urol.* 1995;154(4):1312–1318.
7. Gill IS, Kavoussi LR, Lane BR, et al. Comparison of 1,800 laparoscopic and open partial nephrectomies for single renal tumors. *J Urol.* 2007;178(1):41–46.
8. Permpongkosol S, Link RE, Su LM, et al. Complications of 2,775 urological laparoscopic procedures: 1993 to 2005. *J Urol.* 2007;177(2):580–585.
9. Simmons MN, Gill IS. Decreased complications of contemporary laparoscopic partial nephrectomy: use of a standardized reporting system. *J Urol.* 2007;177(6):2067–2073, discussion 2073.
10. Turna B, Frota R, Kamoi K, et al. Risk factor analysis of postoperative complications in laparoscopic partial nephrectomy. *J Urol.* 2008;179(4):1289–1294, discussion 1294–1285.
11. Ficarra V, Novara G, Secco S, et al. Preoperative aspects and dimensions used for an anatomical (PADUA) classification of renal tumours in patients who are candidates for nephron-sparing surgery. *Eur Urol.* 2009;56:786–793.
12. Kutikov A, Uzzo RG. The R.E.N. A. L. nephrometry score: a comprehensive standardized system for quantitating renal tumor size, location and depth. *J Urol.* 2009;182(3):844–853.
13. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg.* 2004;240(2):205–213.
14. Schiff JD, Palese M, Vaughan ED, Jr., Sosa RE, Coll D, Del Pizzo JJ. Laparoscopic vs open partial nephrectomy in consecutive patients: the Cornell experience. *BJU Int.* 2005;96(6):811–814.
15. Allaf ME, Bhayani SB, Rogers C, et al. Laparoscopic partial nephrectomy: evaluation of long-term oncological outcome. *J Urol.* 2004;172(3):871–873.
16. Porpiglia F, Fiori C, Terrone C, Bollito E, Fontana D, Scarpa RM. Assessment of surgical margins in renal cell carcinoma after nephron sparing: a comparative study: laparoscopy vs open surgery. *J Urol.* 2005;173(4):1098–1101.
17. Van Poppel H, Bamelis B, Oyen R, Baert L. Partial nephrectomy for renal cell carcinoma can achieve long-term tumor control. *J Urol.* 1998;160(3 Pt 1):674–678.
18. Zini L, Patard JJ, Capitanio U, et al. The use of partial nephrectomy in European tertiary care centers. *Eur J Surg Oncol.* 2009;35(6):636–642.
19. Campbell SC, Novick AC, Beldegrun A, et al. Guideline for management of the clinical T1 renal mass. *J Urol.* 2009;182(4):1271–1279.
20. Ng CK, Kauffman EC, Lee MM, et al. A comparison of postoperative complications in open versus robotic cystectomy. *Eur Urol.* 2010;57(2):274–281.
21. Ficarra V, Martignoni G, Lohse C, et al. External validation of the Mayo Clinic stage, size, grade and necrosis (SSIGN) score to predict cancer specific survival using a European series of conventional renal cell carcinoma. *J Urol.* 2006;175(4):1235–1239.
22. Scoll BJ, Uzzo RG, Chen DY, et al. Robot-assisted partial nephrectomy: a large single-institutional experience. *Urology.* 2010;75(6):1328–1334.