2017

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JOURNAL OF ENDOUROLOGY
Volume 31, Number 2, February 2017

Pp. 158–162
DOI: 10.1089/end.2016.0603

Robotic Partial Nephrectomy for Posterior Tumors Through a Retroperitoneal Approach Offers Decreased Length of Stay Compared with the Transperitoneal Approach: A Propensity-Matched Analysis

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Abstract

Introduction: We sought to compare surgical outcomes between transperitoneal and retroperitoneal robotic partial nephrectomy (RPN) for posterior tumors.

Patients and Methods: Using our multi-institutional RPN database, we reviewed 610 consecutive cases for posterior renal masses treated between 2007 and 2015. Primary outcomes were complications, operative time, length of stay (LOS), surgical margin status, and estimated glomerular filtration rate (eGFR) preservation. Secondary outcomes were estimated blood loss, warm ischemia time (WIT), disease recurrence, and disease-specific mortality. Due to significant differences in treatment year and tumor size between approaches, retroperitoneal cases were matched 1:4 to transperitoneal cases based on propensity scores using the greedy algorithm. Outcomes were compared between approaches using the chi-square and Mann–Whitney *U* tests.

Results: After matching, 296 transperitoneal and 74 retroperitoneal cases were available for analysis, and matched groups were well balanced in terms of treatment year, age, gender, race, American Society of Anesthesiologists physical status classification (ASA) score, body mass index, tumor laterality, tumor size, R.E.N.A.L. (radius, exophytic/endophytic properties, nearness of tumor to the collecting system or sinus, anterior/posterior, location relative to polar lines) score, and hilar location. Compared with transperitoneal, the retroperitoneal approach was associated with significantly shorter mean LOS (2.2 *vs* 2.6 days, $p=0.01$), but longer mean WIT (21 *vs* 19 minutes, $p=0.01$). Intraoperative ($p=0.35$) and postoperative complications ($p=0.65$), operative time ($p=0.93$), positive margins ($p=1.0$), and latest eGFR preservation ($p=0.25$) were not significantly different between approaches. No differences were detected in the other outcomes.

Conclusions: Among high-volume surgeons, transperitoneal and retroperitoneal RPN achieved similar outcomes for posterior renal masses, although with slight differences in LOS and WIT. Retroperitoneal RPN may be an effective option for the treatment of certain small posterior renal masses.

Keywords: robotics, renal cancer, laparoscopic approach

Introduction

In robotic partial nephrectomy (RPN), the optimal approach for treating posterior renal masses is often debated. There are several potential advantages of the retroperitoneal approach over the transperitoneal approach.[1,2] Namely, the retroperitoneal approach avoids bowel manipulation, does not require full kidney mobilization, allows direct access to the renal hilum, and contains bleeding and urine leakage to the retroperitoneal space, which altogether may save time, reduce the risk of bowel injury (especially in the setting of prior abdominal surgery), and minimize the risk of postoperative ileus. However, the retroperitoneal approach may be more technically challenging than the transperitoneal approach due to the limited working space of the retroperitoneum and less familiar anatomic landmarks, which may lead to disorientation and

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inadvertent vascular injury.[3] Prior studies comparing these approaches have been limited by small single-institution experiences.[4–7] In fact, the need for a robust high-quality observational study has been advocated.[8] Our objective was to compare surgical outcomes between the transperitoneal and retroperitoneal approaches, specifically for posterior tumors, in our large multi-institutional RPN database.

Patients and Methods

Study population

After obtaining institutional review board approval, we queried our multi-institutional RPN database, which contains comprehensive data on ~2000 consecutive RPNs performed by five high-volume robotic surgeons between 2007 and 2015. The database includes each surgeon's cumulative RPN experience for both transperitoneal and retroperitoneal cases. Three surgeons contributed transperitoneal and retroperitoneal cases to the cohort, while two surgeons contributed only transperitoneal cases. Anterior tumors were treated primarily using the transperitoneal approach, while posterior tumors were treated using either the transperitoneal approach or retroperitoneal approach, with the decision based on patient history of prior abdominal surgery and/or surgeon preference. Only RPN cases for posterior tumors were included in the study. We utilized radiology reports and nephrometry score when available to identify patients with posterior tumors. The transperitoneal and retroperitoneal approaches were performed using standardized techniques, as previously described.[1,2,9]

Study variables

Aside from approach, other variables studied included treatment year, patient age, gender, race, American Society of Anesthesiologists physical status classification (ASA), body mass index (BMI), chronic kidney disease (stage 3 or greater), tumor laterality, clinical tumor size, pathological T stage, R.E.N.A.L. (radius, exophytic/endophytic properties, nearness of tumor to the collecting system or sinus, anterior/posterior, location relative to polar lines) nephrometry score,[10] and hilar tumor location.

Study outcomes

Outcome measures were selected *a priori*. To assess the suggested benefits (i.e., decreased morbidity, expedited recovery, shorter procedure time), oncological efficacy, and functional efficacy of the retroperitoneal approach, we chose intraoperative and 30-day postoperative complications, length of stay (LOS), operative time, surgical margin status, and estimated glomerular filtration rate (eGFR) preservation for our primary outcomes. Secondary outcomes included estimated blood loss, warm ischemia time (WIT), disease recurrence, all-cause death, and disease-specific death. Complications were graded using the Clavien–Dindo classification system. Overall (Clavien 1–5) and major (Clavien 3–5) postoperative complication rates were assigned based on the most severe complication recorded per case. eGFR was calculated using the MDRD equation. eGFR preservation was determined by dividing the latest eGFR by the preoperative eGFR, expressed as a percentage.

Propensity matching

Differences between the retroperitoneal ($n=87$) and transperitoneal ($n=523$) groups were evaluated using the Pearson chi-square test for categorical variables and the Mann–Whitney *U* test for ordinal and continuous variables. In the unmatched cohort, treatment year and tumor size differed significantly between the retroperitoneal and transperitoneal groups (Table 1A). A 1:4 (retroperitoneal:transperitoneal) propensity score-based match was performed using the greedy nearest-neighbor algorithm. The completeness of the match was assured by the fact that 85% ($n=74$) of retroperitoneal cases were matched, and no additional matches could be made. The goodness of the match was evidenced in that no significant differences remained between the groups after matching, and matching was not improved by a 1:5 match.

Statistical analysis

Normally distributed variables are expressed as mean ± standard deviation. Non-normally distributed variables are expressed as median (interquartile range [IQR]). Outcomes were compared between the retroperitoneal and transperitoneal approaches using the Pearson chi-square, Fisher exact, and Mann–Whitney *U* tests. Statistical tests were performed using SAS® University Edition (SAS Institute, Inc., Cary, NC). All tests were two-sided, and statistical significance was considered at $p<0.05$.

Results

In the final matched cohort, 370 RPN cases for posterior renal masses were available for analysis. The 4:1 match yielded 74 retroperitoneal and 296 transperitoneal cases. The matched groups were well balanced in terms of treatment year, age, gender, race, ASA, BMI, chronic kidney disease, tumor laterality, tumor size, T stage, R.E.N.A.L. score, and hilar location (Table 1B). For the matched cohort, the median tumor size was 2.5 cm (IQR 1.9–3.6 cm), and the median R.E.N.A.L. score was 7 (IQR 6–9).

Mean LOS was significantly shorter for the retroperitoneal approach compared with the transperitoneal approach (2.2 *vs* 2.6 days, $p=0.01$). Intraoperative complications ($p=0.35$), overall ($p=0.65$) and major ($p=0.30$) postoperative complications, operative time ($p=0.93$), positive surgical margins ($p=1.0$), and eGFR preservation with 7 months of median follow-up ($p=0.25$) were not significantly different between approaches (Table 2).

Complications for the retroperitoneal and transperitoneal approaches, respectively, included (in order of most to least common) blood transfusion (2.7% *vs* 3.7%, $p=1.0$), respiratory problem (4.1% *vs* 2.7%, $p=0.47$), infection (2.7% *vs* 1.7%, $p=0.63$), angioembolization (1.4% *vs* 1.4%, $p=1.0$), nonischemic cardiovascular problem (0% *vs* 2.7%, $p=0.37$), ileus (0% *vs* 1.0%, $p=1.0$), venous thromboembolism (0% *vs* 0.7%, $p=1.0$), urine leak (0% *vs* 0.7%, $p=1.0$), acute kidney injury with oliguria or requiring hemodialysis (0% *vs* 0.3%, $p=1.0$), myocardial infarction (0% *vs* 0.3%, $p=1.0$), wound (0% *vs* 0.3%, $p=1.0$), and kidney loss (0% *vs* 0.2%, $p=1.0$). Intraoperative complications in the transperitoneal group included 1 adjacent organ injury, 1 open conversion, 0 hollow viscus injuries, 0 vascular injuries, and 5 other intraoperative

Table 1. Case Characteristics by Approach, Before and After Matching

(A) Before matching

Variables	*Total* (N = *610*)	*TA* (n = *523*)	*RA* (n = *87*)	p
Median treatment year (IQR)	2012 (2010–2013)	2012 (2010–2013)	2013 (2011–2014)	**<0.01**
Median age (IQR)	60 (52–66)	60 (52–66)	60 (50–66)	0.60
Male, *n* (%)	363 (59.5)	305 (58.3)	58 (66.7)	0.14
White, *n* (%)	488 (81.2)	416 (80.6)	72 (84.7)	0.37
Median ASA score (IQR)	3 (2–3)	3 (2–3)	2 (2–3)	0.27
Median BMI (IQR), kg/m^2	29.4 (25.2–33.0)	29.3 (25.4–32.9)	29.7 (25.0–33.5)	0.99
Chronic kidney disease, *n* (%)	178 (29.2)	145 (27.7)	33 (37.9)	0.05
Median preoperative eGFR (IQR), mL/min/1.73 m^2	77.1 (63.7–91.6)	77.6 (64.4–92.5)	81.6 (65.8–98.9)	0.14
Left side, *n* (%)	304 (50.1)	264 (50.6)	40 (47.1)	0.55
Median tumor size (IQR), cm	2.7 (1.9–3.7)	2.7 (2.0–3.8)	2.3 (1.8–3.2)	**0.01**
Pathological T stage, *n* (%)[a]				0.75
1	448 (92.8)	382 (92.5)	66 (94.3)	
2	6 (1.2)	6 (1.5)	0	
3	28 (5.8)	24 (5.8)	4 (5.7)	
4	1 (0.21)	1 (0.24)	0	
Median R.E.N.A.L. score (IQR)	7 (6–9)	7 (6–9)	7 (6–9)	0.60
Hilar location, *n* (%)	67 (14.1)	55 (13.2)	12 (21.1)	0.11

(B) After matching

Variables	*Total* (N = *370*)	*TA* (n = *296*)	*RA* (n = *74*)	p
Median treatment year (IQR)	2012 (2011–2014)	2012 (2011–2014)	2013 (2011–2014)	0.89
Median age (IQR)	59 (52–66)	59 (52–66)	60 (50–65)	0.92
Male, *n* (%)	219 (59.2)	168 (56.8)	51 (68.9)	0.06
White, *n* (%)	296 (80.9)	235 (80.2)	61 (83.6)	0.51
Median ASA score (IQR)	3 (2–3)	3 (2–3)	2 (2–3)	0.56
Median BMI (IQR), kg/m^2	29.1 (25.1–32.9)	29.4 (25.1–33.0)	30.0 (25.1–33.9)	0.42
Chronic kidney disease, *n* (%)	111 (30.0)	84 (28.4)	27 (36.5)	0.17
Median preoperative eGFR (IQR), mL/min/1.73 m^2	77.6 (62.5–96.3)	77.0 (62.1–94.7)	83.6 (65.8–100.4)	0.89
Left side, *n* (%)	181 (49.2)	148 (50.0)	33 (45.8)	0.53
Median tumor size, cm (IQR)	2.5 (1.9–3.6)	2.5 (1.9–3.5)	2.4 (1.9–3.3)	0.59
Pathological T stage, *n* (%)[a]				0.87
1	276 (93.6)	218 (93.6)	58 (93.6)	
2	0	0	0	
3	18 (6.1)	14 (6.0)	4 (6.5)	
4	1 (0.34)	1 (0.43)	0	
Median R.E.N.A.L. score (IQR)	7 (6–9)	7 (6–9)	8 (6–9)	0.32
Hilar location, *n* (%)	43 (14.8)	33 (13.6)	10 (20.4)	0.22

[a]Pathological T stage only applies to malignant tumors. There were 483 and 295 malignant tumors in the dataset before and after matching, respectively. Bold type indicates statistical significance.

ASA = American Society of Anesthesiologists physical status classification; BMI = body mass index; eGFR = estimated glomerular filtration rate; IQR = interquartile range; RA = retroperitoneal approach; R.E.N.A.L. = radius, exophytic/endophytic properties, nearness of tumor to the collecting system or sinus, anterior/posterior, location relative to polar lines; TA = transperitoneal approach.

Table 2. Primary Outcomes by Approach

Outcomes	*Total*	*TA*	*RA*	p
Overall complications, *n* (%)	51 (13.8)	42 (14.2)	9 (12.2)	0.65
Major complications, *n* (%)	13 (3.5)	9 (3.0)	4 (5.4)	0.30
Intraoperative complications, *n* (%)	7 (1.9)	7 (2.4)	0	0.35
Mean operative time ± SD, minutes	176 ± 58	176 ± 58	176 ± 59	0.93
Mean LOS ± SD, days	2.5 ± 1.1	2.6 ± 1.2	2.2 ± 0.9	**0.01**
PSM, *n* (%)	6 (1.7)	5 (1.7)	1 (1.4)	1.00
GFR preservation at latest follow-up (%)	85.1 (74.4–99.8)	84.9 (73.6–99.7)	90.4 (76.7–106)	0.25
Median GFR follow-up (IQR), months	7.3 (0.6–24.2)	7.1 (0.5–24.0)	10.5 (2.6–24.9)	0.69

Bold type indicates statistical significance.

LOS = length of stay; PSM = positive surgical margins; SD = standard deviation.

Table 3. Secondary Outcomes by Approach

Outcomes	*Total*	*TA*	*RA*	p
Mean EBL ± SD, mL	182 ± 215	190 ± 239	150 ± 62	0.18
Mean WIT ± SD, minute	19 ± 8.3	19 ± 8.5	21 ± 6.9	**0.01**
Recurrence, *n* (%)	3 (0.8)	1 (0.3)	2 (2.7)	0.10
All-cause death, *n* (%)	2 (0.6)	2 (0.7)	0	1.00
Cancer-specific death, *n* (%)	1 (0.4)	1 (0.5)	0	1.00

Bold type indicates statistical significance.
EBL = estimated blood loss; WIT = warm ischemia time.

complications. There were no intraoperative complications in the retroperitoneal group.

In regard to secondary outcomes, WIT was the only outcome found to differ between approaches (Table 3). Compared with the retroperitoneal approach, the transperitoneal approach was associated with a significantly shorter WIT (19 *vs* 21 minutes, $p = 0.01$). Estimated blood loss was not significantly different between the retroperitoneal and transperitoneal approaches, respectively (150 *vs* 190 mL, $p = 0.18$). With a median overall follow-up of 15 months, the rates of disease recurrence, all-cause death, and disease-specific death did not differ significantly between approaches.

Discussion

Retroperitoneal and transperitoneal RPN are both surgical options for the treatment of posterior renal masses.[11] While retroperitoneal RPN is technically feasible for the treatment of anterior or lateral renal masses, it is a more challenging operation due to increased external instrument clashing when approaching the anterior renal surface through the retroperitoneal approach. However, it has been suggested that the retroperitoneal approach is ideally suited for treatment of posterior renal masses because it provides direct access to the posterior surface of the kidney and renal hilum while avoiding bowel manipulation and peritoneal violation.[12,13] These unique features of the retroperitoneal approach have theoretical advantages, namely decreased operative time, decreased morbidity, and expedited recovery due to less risk of ileus.

In clinical practice, there is inherent bias in selecting the RPN approach based on tumor location and surgical history, which has made direct comparisons between the two approaches difficult. Specifically, the transperitoneal approach is used more for anterior tumors, and the retroperitoneal approach is used more for posterior tumors or for anterior tumors in patients with prior abdominal surgery who may not be candidates for transperitoneal surgery.[14] Prior observational studies did not detect a difference in surgical outcomes between approaches, except for potentially shorter operative times with the retroperitoneal approach.[4–6] However, these studies were limited by small samples sizes and did not account for treatment selection bias, threatening the validity of their results. In these single-center studies, sample size constraints prevented a specific analysis of outcomes for posterior renal masses. With the ample sample size afforded by our multi-institutional RPN database, we performed a 1:4 matched comparison between retroperitoneal and transperitoneal RPN, focusing exclusively on the treatment of posterior tumors.

In our study, we confirm that the retroperitoneal and transperitoneal RPN approaches achieve generally similar surgical outcomes for posterior tumors. The main positive finding was that retroperitoneal RPN affords approximately a half-day shorter LOS, on average, compared with the transperitoneal approach. While this difference was statistically significant ($p = 0.01$), the clinical and economic significance of this difference remains to be seen. Due to the unblinded retrospective nature of this study and the perceived benefit of the retroperitoneal approach, surgeon bias may have influenced discharge practice patterns in favor of patients treated with retroperitoneal RPN. Aside from bias, multiple other factors may have contributed to the shorter LOS seen with retroperitoneal RPN. Faster gastrointestinal recovery, which has been asserted as a potential advantage of the retroperitoneal approach, is one possible explanation for the shorter LOS seen in this group; however, ileus rates were low (0.8%) in our cohort and did not differ significantly between approaches. Decreased surgical morbidity and shorter operative time, other potential benefits of the retroperitoneal approach, also may have contributed to the shorter LOS. However, neither complication rates nor operative times were found to be significantly different between the retroperitoneal and transperitoneal approaches in our analysis.

We also found a significant difference in WITs between approaches, with the retroperitoneal approach associated with two more minutes of warm ischemia than the transperitoneal approach. Nevertheless, since all surgeons were highly experienced, WITs were short, primarily staying within the 25-minute cutoff that is associated with an increased risk of *de novo* stage IV chronic kidney disease.[15,16] Furthermore, the difference in WIT between approaches did not appear to be clinically significant in our study, causing no difference in latest eGFR preservation. However, for novice surgeons who may require longer WITs, this difference may become clinically relevant. Other important surgical outcomes, including intraoperative complications, major postoperative complications, and positive surgical margin rates, were roughly equivalent between approaches.

In the only other study to compare retroperitoneal ($n = 116$) and transperitoneal ($n = 97$) RPN for posterior tumors, Kim and colleagues showed that the transperitoneal approach was associated with 7.4-fold higher odds of LOS greater than 1 day *vs* LOS equal to 1 day in logistic regression analysis.[7] This effect was unusually high, 4.6-fold higher than the only other significant predictor in their model—tumor size—and confidence intervals were not supplied, raising concerns about their statistical methodology. With only 76 events (patients with LOS equal to 1 day) in the study and 12 predictor variables in their multivariable analysis, this model may have been overfit, decreasing confidence in the reported findings. Furthermore, the majority of retroperitoneal RPN cases in their study were performed during the later years of the study period, at a time of when early discharge care pathways were being implemented nationally, yet they did not account for treatment year in their multivariable model, which may have further confounded their LOS results.[17] By comparison, in our study, we matched our groups for treatment year to minimize potential bias associated with this confounder.

Our study has limitations to acknowledge, including potential bias related to the retrospective design, the inability to

match 15% of retroperitoneal cases, and the inability to adjust for unknown confounders. Furthermore, our findings may not be generalizable to those of lower-volume hospitals or less experienced surgeons. Last, while we did not find a difference in disease recurrence or survival outcomes between approaches, longer follow-up is needed to confirm these findings.

Conclusions

In conclusion, for highly skilled robotic surgeons, retroperitoneal RPN is effective for the treatment of small (<4 cm) renal masses. The retroperitoneal approach offers slightly decreased LOS; however, the clinical and/or economic benefit, if any, of this incremental improvement requires further study. Ultimately, good results can be achieved with either approach; therefore, surgeons should base the choice of surgical approach on their own clinical judgment and experience.

Author Disclosure Statement

The authors deny any financial or material research support for this work. Dr. Kaouk is a consultant for HealthTronics, Inc. Dr. Bhayani is a consultant for SurgiQuest, Inc. Dr. Rogers is a lecturer for Intuitive Surgical, Inc. Dr. Stifelman is a consultant for SurgiQuest, Inc., and VTI Instruments, Inc., and a lecturer for Intuitive Surgical, Inc. The remaining authors have no financial disclosures.

References

1. Feliciano J, Stifelman M. Robotic retroperitoneal partial nephrectomy: A four-arm approach. JSLS 2012;16:208–211.
2. Ghani KR, Porter J, Menon M, et al. Robotic retroperitoneal partial nephrectomy: A step-by-step guide. BJU Int 2014;114:311–313.
3. McAllister M, Bhayani SB, Ong A, et al. Vena caval transection during retroperitoneoscopic nephrectomy: Report of the complication and review of the literature. J Urol 2004;172:183–185.
4. Tanaka K, Shigemura K, Furukawa J, et al. Comparison of the transperitoneal and retroperitoneal approach in robot-assisted partial nephrectomy in an initial case series in Japan. J Endourol 2013;27:1384–1388.
5. Hughes-Hallett A, Patki P, Patel N, et al. Robot-assisted partial nephrectomy: A comparison of the transperitoneal and retroperitoneal approaches. J Endourol 2013;27:869–874.
6. Choo SH, Lee SY, Sung HH, et al. Transperitoneal versus retroperitoneal robotic partial nephrectomy: Matched-pair comparisons by nephrometry scores. World J Urol 2014; 32:1523–1529.
7. Kim EH, Larson JA, Potretzke AM, et al. Retroperitoneal robot-assisted partial nephrectomy for posterior renal masses is associated with earlier hospital discharge: A single-institution retrospective comparison. J Endourol 2015;29:1137–1142.
8. Xia L, Zhang X, Wang X, et al. Transperitoneal versus retroperitoneal robot-assisted partial nephrectomy: A systematic review and meta-analysis. Int J Surg 2016;30:109–115.
9. Kaouk JH, Khalifeh A, Hillyer S, et al. Robot-assisted laparoscopic partial nephrectomy: Step-by-step contemporary technique and surgical outcomes at a single high-volume institution. Eur Urol 2012;62:553–561.
10. Simhan J, Smaldone MC, Tsai KJ, et al. Objective measures of renal mass anatomic complexity predict rates of major complications following partial nephrectomy. Eur Urol 2011;60:724–730.
11. Harris KT, Ball MW, Gorin MA, et al. Transperitoneal robot-assisted partial nephrectomy: A comparison of posterior and anterior renal masses. J Endourol 2014;28:655–659.
12. Wright JL, Porter JR. Laparoscopic partial nephrectomy: Comparison of transperitoneal and retroperitoneal approaches. J Urol 2005;174:841–845.
13. Patel M, Porter J. Robotic retroperitoneal partial nephrectomy. World J Urol 2013;31:1377–1382.
14. Hu JC, Treat E, Filson CP, et al. Technique and outcomes of robot-assisted retroperitoneoscopic partial nephrectomy: A multicenter study. Eur Urol 2014; 66:542–549.
15. Thompson RH, Lane BR, Lohse CM, et al. Every minute counts when the renal hilum is clamped during partial nephrectomy. Eur Urol 2010;58:340–345.
16. Thompson RH, Lane BR, Lohse CM, et al. Renal function after partial nephrectomy: Effect of warm ischemia relative to quantity and quality of preserved kidney. Urology 2012; 79:356–360.
17. Patel A, Golan S, Razmaria A, et al. Early discharge after laparoscopic or robotic partial nephrectomy: Care pathway evaluation. BJU Int 2014;113:592–597.

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Abbreviations Used

ASA = American Society of Anesthesiologists physical status classification
BMI = body mass index
eGFR = estimated glomerular filtration rate
IQR = interquartile range
LOS = length of stay
R.E.N.A.L. = radius, exophytic/endophytic properties, nearness of tumor to the collecting system or sinus, anterior/posterior, location relative to polar lines
RPN = robotic partial nephrectomy
WIT = warm ischemia time