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ORIGINAL ARTICLE

Retroperitoneal *vs.* transperitoneal robotic partial nephrectomy: a multicenter propensity-score matching analysis (PADORA Study - UroCCR n° 68)

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ABSTRACT

BACKGROUND: Robot-assisted partial nephrectomy can be performed through either a transperitoneal or retroperitoneal approach. This study aimed to compare the rate of trifecta achievement between retroperitoneal (RRPN) and transperitoneal (TRPN) robot-assisted partial nephrectomy using a large multicenter prospectively-maintained database and propensity-score matching analysis.

METHODS: This study was launched by the French Kidney Cancer Research Network, under the UroCCR Project (NCT03293563). Patients who underwent TRPN or RRPN by experienced surgeons in 15 participating centers were included. Data on demographic and clinical parameters, tumor characteristics, renal function, and surgical parameters were collected. The primary outcome was the rate of trifecta achievement, which was defined as a warm ischemia time of less than 25 minutes, negative surgical margins, and no major complications. Secondary outcomes included operative time, hospital length-of-stay, blood loss, postoperative complications, postoperative renal function, and each trifecta item taken alone. Subgroup analysis was done according to tumor location.

RESULTS: A total of 2879 patients (2581 TRPN *vs*. 298 RRPN) were included in the study. Before matching, trifecta was achieved in 73.0% of the patients in the TRPN group compared to 77.5% in the RRPN group (P=0.094). After matching 157 patients who underwent TRPN to 157 patients who underwent RRPN, the trifecta rate was 82.8% in the TRPN group *vs*. 84.0% in the RRPN group (P=0.065). The RRPN group showed shorter operative time (123 *vs*. 171 min; P<0.001) and less blood loss (161 *vs*. 293 mL; P<0.001). RRPN showed a higher trifecta achievement for posterior tumors than TRPN (71% *vs*. 81%; P=0.017).

CONCLUSIONS: RRPN is a viable alternative to the transperitoneal approach, particularly for posterior renal tumors, and is a safe and effective option for partial nephrectomy.

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KEY WORDS: Nephrectomy; Robotic surgical procedures; Retroperitoneal space.

Robot-assisted partial nephrectomy (RPN) is an increasingly popular option for the surgical management of renal tumors suitable for a nephron-sparing surgery. Compared to open surgery, RPN offers enhanced postoperative recovery without compromising functional, perioperative, and oncological outcomes, as well as shorter hospital stays and warm ischemia time (WIT), and lower rates of conversion to radical surgery compared to the conventional laparoscopic approach.[1-4] Furthermore, RPN is more expedient for tumor excision and renorrhaphy, which has helped expand surgical indications in large and complex tumors.[5]

While the transperitoneal approach is the more traditional approach, it has several drawbacks, including ex-officio peritoneal violation, technical difficulty in the presence of peritoneal adhesions in multi-operated patients, and difficulty accessing posterior tumors, where the kidney must be freed from its attachments to gain posterior access.[6] The retroperitoneal approach for RPN was developed to address these limitations by avoiding peritoneal adhesions in patients with prior intra-abdominal surgery and providing direct access to the renal artery as well as posterior tumors without the necessity of liberating the colon or rotating the kidney.[7] Additionally, the absence of peritoneal violation helps contain any urinary leaks or residual blood in the retroperitoneal space.[7]

While two recent meta-analyses have shown that retroperitoneal robotic partial nephrectomy (RRPN) resulted in a significantly shorter hospital length-of-stay compared to transperitoneal robotic partial nephrectomy (TRPN), there were no advantages over TRPN regarding perioperative outcomes such as WIT and blood loss.[8, 9] However, all these outcomes were analyzed separately. The trifecta for RPN, as defined by Khalifeh *et al.*, is the combination of a WIT of less than 25 minutes, negative surgical margins, and no major perioperative complications.[10]

The aim of our study was to compare the rate of trifecta achievement between RRPN and TRPN in a large multicentric prospectively-maintained database using propensity-score matching analysis.

Materials and methods

Patients

This retrospective multi-institutional cohort study was launched by the French Kidney Cancer Research Network, under the UroCCR project (NCT03293563), which is IRB-approved, and obtained the CNIL authorization number DR-2013-206. Data were collected from a prospectively-maintained multicentric database of 15 French centers, from January 2000 to July 2021, comprising patients who underwent RPN by experienced surgeons in each center, either by a transperitoneal or a retroperitoneal approach. During the observed period, 9 out of the 15 participating centers performed RRPN procedures, with some centers only contributing TRPN cases.

This study was conducted in accordance with the relevant guidelines and regulations.[11] All patients received oral and written information about the objectives and methodology of the UroCCR project and written consent was obtained. After ethical approval (Comité de Protection des Personnes Sud-Ouest et Outre-mer III, decision number DC 2012/108), data were prospectively collected for each patient.

Patients with a renal graft and those with incomplete data were excluded from this study.

Data acquisition and measurements

Demographic and clinical parameters, as well as tumor characteristics (side, size in cm, location, exophytic proportion, cystic nature, complexity using PADUA nephrometry score, and cTNM classification), were collected.

Preoperative and postoperative renal function were evaluated using creatinine clearance according to the Modification of Diet in Renal Disease formula (MDRD) and based on the creatinine level measured in µmol/L.

Surgical parameters that were evaluated included surgical approach (TRPN vs. RRPN), WIT, image-guided surgery, fluorescence-guided surgery, operative time, blood loss, transfusion, perioperative complications, postoperative medical and surgical complications up to 3 months after surgery according to the Clavien-Dindo classification, and surgical margins according to the final pathology report.

Outcomes

Patients were divided into two groups according to the surgical approach (TRPN *vs*. RRPN). The primary outcome for comparison between these two groups was the proportion of trifecta achievement, defined as the following:[10]

- warm ischemia time (WIT) less than 25 minutes;
- negative surgical margins;
- no major complications.

All these three conditions were necessary in order to achieve the primary outcome.

Secondary outcomes were operative time, hospital length-of-stay, blood loss, postoperative complications, postoperative renal function, and each of the trifecta's items taken alone, namely, WIT <25 min, negative surgical margins, and the absence of major complications.

Statistical analysis

The normality of quantitative parameters was tested using histogram shapes and QQ normality plots. Mean and standard deviation were used for normally distributed variables, while median and interquartile range were used for non-normally distributed variables. Proportion was used to describe qualitative parameters. In order to compare baseline characteristics, the *t*-test or Mann-Whitney Test were used to compare quantitative parameters according to the normality of the concerned variable, and the chi-square test was used to compare qualitative parameters. A comparison was done between the two approaches using logistic linear regression, taking into consideration all parameters.

Thereafter, a propensity-score matching was done in order to control for potential bias in baseline demographic, clinical, and tumoral characteristics between the two groups, reducing therefore the conventional bias associated with standard multivariate analysis.

The primary and secondary outcomes were compared between the newly formed propensity score-matched cohorts. Finally, a subgroup analysis was done in groups divided according to tumor location, in order to see if any surgical approach is preferred in certain tumor locations.

Statistics were done using STATA® (v14.2). A P<0.05 was considered a statistically significant.

Data availability

The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

Results

Before matching

After excluding patients with a renal graft and those with incomplete data, a total of 2879 patients aged 60±13 years were included in the study. 2581 patients (90%) underwent TRPN while 298 (10%) underwent RRPN. Baseline characteristics of these patients as well as baseline comparison between both groups are shown in Table I. The number of RRPN cases performed by each center ranged from 11 to 94 with an average of 33 cases per center.

Trifecta was achieved in 73% of patients who underwent TRPN compared to 78% of patients who underwent RRPN. However, this difference was not statistically significant (P=0.09).

A WIT <25 min was achieved in 93% of patients in the RRPN group compared to 86% of patients in the TRPN group (P=0.001). Negative surgical margins were achieved in 84% of patients in the RRPN group compared to 89% in the TRPN group (P=0.02). No difference was found for the absence of perioperative complications (96% *vs*. 95%, P=0.897). Mean operative time was 177 mins in the TRPN group compared to 114 mins in the RRPN group (P<0.001). Blood loss was 292 ml in the TRPN group compared to 145 ml in the RRPN group (P<0.001). Statistically significant difference was found in favor of RRPN compared to TRPN for bleeding (0.7% *vs*. 1.7% respectively; P=0.04), bowel injury (0% *vs*. 0.2% respectively; P<0.001), and vascular injury (0% *vs*. 0.4%, respectively; P<0.001), and in favor of TRPN compared to RRPN for conversion to open surgery (1% *vs*. 1.7% respectively; P=0.03) (Supplementary Digital Material 1: Supplementary Table I). No difference was found for postoperative medical and surgical complications (P=0.54 and P=0.17, respectively).

Taking into consideration the significant differences between the two groups regarding

TABLE I.—*Baseline demographic and tumoral characteristics, as well as renal function evaluation, surgical parameters and trifecta outcomes, before matching.*

Variable	Overall (N.=2879)	TransP (N.=2581)	RetroP (N.=298)	P value
Demographics				
Age (mean±SD), years	60±13	59±13	61±13	0.51
Sex (M:F)	1.8:1	1.8:1	2.1:1	0.24
ASA	615 (21%)	549 (22%)	66 (24%)	0.51
I				
II	1666 (58%)	1498 (60%)	168 (62%)	
III	460 (16%)	423 (17%)	37 (14%)	
IV	10 (0.3%)	9 (0.4%)	1 (0.4%)	
ECOG (%)	2089 (73%)	1888 (80%)	201 (76%)	0.42
0				
1	464 (16%)	408 (17%)	56 (21%)	
2	70 (2.4%)	64 (2.7%)	6 (2.3%)	
3	15 (0.5%)	13 (0.5%)	2 (0.7%)	
History of abdominal surgery	980 (34%)	897 (35%)	83 (28%)	0.02*
Tumor characteristics				
Tumor side				0.14
Right	1476 (51%)	1311 (51%)	165 (55%)	
Left	1403 (49%)	1270 (49%)	133 (45%)	
Size, cm (mean±SD)	3.4±2.0	3.4±2.0	3.3±3.1	<0.001*
Tumor location				0.8
Superior pole	1010 (35%)	914 (39%)	96 (40%)	
Equator	904 (31%)	835 (36%)	69 (29%)	0.03*
Inferior pole	908 (32%)	826 (35%)	82 (34%)	0.71
Anterior	1293 (52%)	1231 (55%)	62 (28%)	<0.001*
Posterior	1184 (48%)	1025 (45%)	159 (72%)	
Lateral	1642 (66%)	1503 (67%)	139 (63%)	0.21
Medial	830 (34%)	747 (33%)	83 (37%)	
Exophytic proportion				0.008*
<50%	1245 (50%)	1120 (55%)	125 (67%)	
≥50%	963 (39%)	901 (45%)	62 (33%)	
Cystic nature	427 (17%)	382 (17%)	45 (21%)	<0.001*
PADUA score				<0.001*
1	756 (32%)	674 (31%)	82 (44%)	
2	846 (36%)	775 (36%)	71 (38%)	
3	760 (32%)	725 (33%)	35 (19%)	
cT				<0.001*
cT1a	23 (0.8%)	23 (0.9%)	0 (0%)	
cT1b	1642 (60%)	1428 (58%)	214 (80%)	
cT2a	816 (30%)	773 (31%)	43 (16%)	
cT2b	7 (0.3%)	7 (0.3%)	0 (0%)	
cT3a	160 (5.8%)	158 (6.4%)	2 (0.7%)	
cT3b	35 (1.3%)	34 (1.4%)	1 (0.4%)	
cT3c	5 (0.2%)	5 (0.2%)	0 (0%)	
cT4	49 (1.8%)	41 (1.7%)	8 (3.0%)	
cTx	6 (0.2%)	6 (0.2%)	0 (0%)	
Renal function				
Creatinine preoperative (mean±SD), µmol/L	101±45	102±46	87±31	<0.001*
Creatinine after leaving hospital (mean±SD), µmol/L	97±44	99±45	85±34	<0.001*
MDRD preoperative (mean±SD), mL/min	85±34	84±25	97±86	0.24
MDRD after leaving hospital (mean±SD), mL/min	83±37	81±20	92±73	0.06
Surgical parameters				
Clamping	2348 (82%)	2063 (80%)	285 (96%)	<0.001*
Warm ischemia time (mean±SD), min	14±11	14±12	13±7	0.75
Image-guided surgery	519 (18%)	489 (19%)	30 (10%)	<0.001*
Fluorescence-guided surgery	88 (3%)	84 (3%)	4 (1%)	0.07
Operative time (min)	172±99	177±101	114±54	<0.001*
Blood loss (mL)	280±342	292±339	145±358	<0.001*
Transfusion	195 (6.8%)	175 (6.8%)	20 (6.8%)	0.34
Postoperative surgical complications	149 (5.1%)	127 (5.0%)	22 (7.5%)	0.17
Postoperative medical complications	307 (10.6%)	280 (10.9%)	27 (9.2%)	0.55
Hospital length-of-stay (mean±SD), days	3.4±3.2	3.4±3.3	4.0±3.0	0.59
Death	7 (0.2%)	6 (0.2%)	1 (0.3%)	0.27
Trifecta outcomes				
Warm ischemia time <25 min	2495 (87%)	2218 (86%)	277 (93%)	0.001*
Negative surgical margins	2534 (88%)	2284 (89%)	250 (84%)	0.021*
Absence of major complications	2748 (95%)	2464 (96%)	284 (95%)	0.9
Trifecta achieved	2115 (74%)	1884 (73%)	231 (78%)	0.09

TransP: transperitoneal; RetroP: retroperitoneal; SD: standard deviation; ASA: American Society of Anesthesiology score; ECOG: Eastern Cooperative Oncology Group score.
*Statistically significant difference.

baseline characteristics, and in order to limit this heterogeneity bias, a propensity-score matched analysis was conducted.

Propensity-score matching

In all, 157 patients could be matched in each group, with a total of 314 patients included: 157 patients who underwent TRPN were matched with 157 patients who underwent RRPN. No statistically significant difference was found between all baseline characteristics (P>0.05) (Table II).

Trifecta was achieved in 83% of patients who underwent TRPN compared to 84% of patients who underwent RRPN. This difference was not statistically significant (P=0.065).

Regarding secondary outcomes, after nearest-neighbor matching:

• no statistically significant difference was found between TRPN and RRPN for negative surgical margins (93% *vs*. 89% respectively, P=0.23), a WIT <25 min achievement (92% *vs*. 94%, respectively, P=0.38), or the absence of perioperative complications (98 *vs*. 96%, respectively, P=0.52).

• a statistically significant difference was still found between TRPN and RRPN for operative time (171 *vs*. 123 min; P<0.001) and for blood loss (293 *vs*. 161 mL; P<0.001). However, no difference in transfusion rate was found (2% *vs*. 2.5%; P=0.34).

• no statistically significant difference was found for medical and surgical postoperative complications between TRPN and RRPN, length-of-stay, postoperative renal function, or death (P>0.05) (Table II). To note, four Clavien-Dindo ≥3 complications (2%) were found in the TRPN group compared to nil (0%) in the RRPN group.

Subgroup analysis

Our subgroup analysis did not identify any statistically significant differences between the two approaches for achieving trifecta in equatorial (69% in TRPN *vs*. 74% in RRPN; P=0.4), inferior pole (75% in TRPN *vs*. 81% in RRPN; P=0.2), and anterior tumors (75% in TRPN *vs*. 77% in RRPN; P=0.6). In other words, the rate of trifecta achievement was similar for both approaches in these specific tumor locations. A statistically significant difference in trifecta achievement was found for posterior tumors between TRPN and RRPN (71% *vs*. 81%; P=0.017). A tendency towards a statistically significant difference was found for superior pole tumors in favor of RRPN (72% *vs*. 80%; P=0.051).

Discussion

This study represents the largest series of RPN to date, comparing 2879 patients who underwent either TRPN (N.=2581) or RRPN (N.=298). Our study confirmed that RRPN is a non-inferior surgical approach in terms of the rate of trifecta achievement when compared to TRPN. This finding holds regardless of tumor location or surgical complexity. Specifically, our results demonstrated no difference between TRPN and RRPN in terms of WIT, negative surgical margins, and the absence of complications. In addition, RRPN had a reduced operative time and less blood loss compared to TRPN.

In terms of surgical outcomes, the achievement of trifecta criteria is a key measure of success in partial nephrectomy.[12] Several studies have compared the trifecta achievement between retroperitoneal and transperitoneal robotic partial nephrectomy (RRPN and TRPN, respectively), with mixed results.

Harke *et al.* conducted a multi-center match-pair analysis of 754 patients who underwent RPN and found that the trifecta criteria were achieved in 90% of the RRPN group and 88% of the TRPN group, without differences for tumor location.[13] Similarly, Sharma *et al.* found that trifecta was better achieved with RRPN compared to TRPN (70.2% *vs*. 53%, P<0.001).[14] These findings were confirmed by Mittakanti *et al.* and Arora *et al.* for each trifecta criterion taken alone.[15, 16] Choi *et al.* expanded on the trifecta criteria by adding return of renal function to >90% from baseline and no upstaging of chronic kidney disease, creating a "pentafecta" measure of success.[17] In their study of 566 patients undergoing RPN, no difference in achieving the pentafecta was found between RRPN and TRPN in all patients and particularly in patients with ≥4 cm renal tumors. Finally, the RECORD 2 project, an Italian multi-insti-

TABLE II.—*Baseline demographic and tumoral characteristics, as well as renal function evaluation, surgical parameters and trifecta outcomes, after propensity-score nearest-neighbor matching.*

Variable	TransP (N.=157)	RetroP (N.=157)	P value
Demographics			
Age (mean), years	61	61	0.71
Sex (M:F)	1.96:1	1.96:1	0.99
ASA (%)			0.83
I	46 (29%)	44 (28%)	
II	86 (55%)	91 (58%)	
III	25 (16%)	22 (14%)	
IV	0 (0%)	0 (0%)	
ECOG (%)			0.81
0	131 (83%)	133 (85%)	
1	24 (15%)	21 (13%)	
2	2 (1.3%)	3 (1.9%)	
3	0 (0%)	0 (0%)	
History of abdominal surgery	70 (45%)	64 (41%)	0.49
Tumor characteristics			
Tumor side (%)			0.82
Right	72 (46%)	74 (47%)	
Left	85 (54%)	83 (53%)	
Size (mean), cm	3.3	3.4	0.99
Tumor location			0.73
Superior pole	59 (38%)	56 (36%)	
Equator	43 (27%)	50 (32%)	0.39
Inferior pole	58 (37%)	61 (39%)	0.73
Anterior	38 (24%)	39 (25%)	0.9
Posterior	119 (76%)	118 (75%)	
Lateral	103 (66%)	102 (65%)	0.28
Medial	54 (34%)	55 (35%)	
Exophytic proportion			0.39
<50%	104 (66%)	95 (61%)	
≥50%	46 (29%)	50 (32%)	
≈100%	7 (0.1%)	12 (7.6%)	
Cystic nature	32 (20%)	26 (17%)	0.43
PADUA score			0.41
1	63 (41%)	66 (43%)	
2	54 (35%)	61 (40%)	
3	36 (23%)	27 (18%)	
cT (%)			0.09
cT1a	0 (0%)	0 (0%)	
cT1b	114 (73%)	127 (81%)	
cT2a	40 (26%)	26 (17%)	
cT2b	0 (0%)	0 (0%)	
cT3a	2 (1.3%)	1 (0.6%)	
cT3b	1 (0.6%)	0 (0%)	
cT3c	0 (0%)	0 (0%)	
cT4	0 (0%)	3 (1.9%)	
cTx	0 (0%)	0 (0%)	
Renal function			
Creatinine J0 (mean), µmol/L	88	91	0.45
Creatinine after leaving hospital (mean), µmol/L	100	111	0.1
MDRD preoperative (mean±SD), mL/min	84±20	80±24	0.27
MDRD after leaving hospital (mean±SD), mL/min	80±24	80±25	0.45
Surgical parameters			
Clamping	149 (96%)	153 (98%)	0.76
Warm ischemia time (mean±SD), min	14±11	12±8.1	0.13
Image-guided surgery	16 (10%)	9 (5.7%)	0.14
Operative time (min)	171±94	123±55	<0.001*
Blood loss (mL)	293±348	161±330	<0.001*
Transfusion	3 (1.9%)	4 (2.5%)	0.34
Postoperative surgical complications	7 (4.5%)	7 (4.5%)	0.99
Postoperative medical complications	11 (7.1%)	12 (7.7%)	0.83
Hospital length-of-stay (mean±SD), days	3.6±2.8	3.6±2.8	0.55
Death	1 (0.6%)	0 (0%)	0.32
Trifecta outcomes			
Warm ischemia time <25 min	144 (92%)	148 (94%)	0.38
Negative surgical margins	146 (93%)	140 (89%)	0.23
Absence of major complications	153 (98%)	151 (96%)	0.52
Trifecta achieved	130 (83%)	132 (84%)	0.07

TransP: transperitoneal; RetroP: retroperitoneal; SD: standard deviation; ASA: American Society of Anesthesiology score; ECOG: Eastern Cooperative Oncology Group score.
*Statistically significant difference.

tutional cohort of 1669 patients operated with minimally-invasive partial nephrectomy, showed comparable results between retroperitoneal and transperitoneal access in terms of complications, positive surgical margins, and renal function.[18] In our study, equal trifecta outcomes were found between RRPN and TRPN when using nearest-neighbor matching.

Regarding the secondary outcomes, our study demonstrated a significant reduction in blood loss in favor of RRPN compared to TRPN. These findings are consistent with the majority of published studies[15-17, 19-21] and recent meta-analyses[22, 23] while only two studies have reported no difference in estimated blood loss between the two approaches.[24, 25] Hospital length-of-stay did not differ significantly between TRPN and RRPN in our study, although most of the published studies to date have shown that RRPN results in a shorter hospital stay.[22, 23, 26, 27] With regards to operative time, our study demonstrated that RRPN significantly reduced it compared to TRPN. This finding is in line with the majority of studies,[13-15, 18] while some studies have shown no difference between both approaches.[16, 26, 27]

The anatomical location of the renal mass is a crucial factor in selecting the RPN surgical approach.[7] In our subgroup analysis, RRPN was significantly superior to TRPN for posterior tumors, and tended to be superior to TRPN for upper pole tumors in achieving trifecta outcomes. Stroup *et al.* Stroup *et al.* reported comparable pentafecta achievement rates with increased utility of RRPN in posterior tumors.[24] Carbonara *et al.* demonstrated similar postoperative, functional, and oncological outcomes for patients with posterior renal tumors.[8] However, in a study by Maurice *et al.*, a longer WIT was observed for RRPN compared to TRPN (21 *vs*. 19 minutes, P=0.01), with no difference in margins and complications.[26] Gu *et al.* found that both TRPN and RRPN are safe and efficacious for completely upper pole renal masses, with no difference in operative time and trifecta criteria, and significantly less blood loss with RRPN.[20] Dell'Oglio *et al.* showed that the notion of using the transperitoneal approach only for anterior tumors and the retroperitoneal approach for posterior tumors is not entirely true since there is no significant difference in the trifecta criteria, regardless of tumor location.[19] Therefore, RRPN can also be safely used in anterior tumors without compromising trifecta outcomes, as shown in our series of patients.

All of the aforementioned findings confirm that RRPN is either non-inferior or superior to TRPN in terms of all primary and secondary outcomes. None of the surgical outcomes showed superiority for TRPN. Additionally, RRPN has been shown to offer better postoperative quality of life and recovery, including physical comfort, emotional state, physical independence, and pain, as compared to TRPN.[28]

This study provides important insights into patient selection for optimal surgical approach in robotic partial nephrectomy. Our findings suggest that patients with posterior and superior tumors may benefit from retroperitoneal robotic partial nephrectomy (RRPN) over transperitoneal robotic partial nephrectomy (TRPN). Notably, RRPN showed a 0% rate of bowel injury and vascular injury, as well as less blood loss, while achieving the same rate of trifecta achievement as TRPN. Importantly, there were no differences in complications between the two approaches following propensity-score matching. Our findings are consistent with the traditional approach used in open surgery, where retroperitoneal access is typically preferred. As such, the use of RRPN in robotic partial nephrectomy seems logical. Given these results, we recommend that urologists consider RRPN as a preferred approach for select patients. This approach should also be incorporated into surgical training programs.

Limitations of the study

This study is, however, not devoid of limitations. Firstly, it is a retrospective study, which is less robust than randomized prospective trials. Propensity-score matching, which was used to match patients in the RRPN and TRPN groups, does not eliminate the risk of selection bias, attrition bias, and residual confounding inherent in all retrospective studies. In particular, residual confounding related to the factors that drive the choice of retro- vs transperitoneal approach may have affected patient outcomes. Furthermore, the study was heavily skewed towards TRPN, with only 11% of patients undergoing RRPN, and

the RRPN group consisted mostly of posterior tumors, which may have introduced a selection bias. Although we acknowledge the potential bias introduced by the variation in the number of RRPN cases performed by each center, we were unable to conduct a sensitivity analysis due to limitations in our data. Future studies with a larger sample size and more balanced distribution of cases across centers are warranted to validate our findings. It should also be noted that RRPN is mostly performed in tertiary care expert centers, while TRPN is performed in a wider range of centers by surgeons of varying expertise, which could have biased the results. The surgeon's experience was not evaluated or taken into account in the matching process. Prospective oncological outcomes were not evaluated.

While our study focused on comparing the outcomes of retroperitoneal and transperitoneal robotic partial nephrectomy, it is important to note that there are other options for nephron-sparing surgery, including laparoscopic partial nephrectomy and ablative techniques. These techniques may have their own potential benefits and limitations, and were not discussed in this study.[29]

Conclusions

In conclusion, our study provides further evidence that RRPN is a viable alternative to the transperitoneal approach, particularly for posterior renal tumors. Despite some limitations, the results support the use of RRPN as a safe and effective option for RPN, and suggest that it should be considered in the armamentarium of minimally invasive kidney surgeons.

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Conflicts of interest

Jean-Christophe Bernhard, Christophe Vassen, Nicolas Doumerc, and Alexandre Ingels are consultants for Intuitive Surgery®. All other authors have no conflict-of-interest to disclose.

Authors' contributions

Conception and design: Georges Mjaess, and Alexandre Ingels. Data acquisition: Georges Mjaess, Jean-Christophe Bernhard, Zine-Eddine Khene, Nicolas Doumerc, Christophe Vaessen, François Henon, Franck Bruyere, Martin Brenier, Bastien Parier, Simone Albisinni, and Alexandre Ingels. Data analysis and interpretation: Georges Mjaess, Jean-Christophe Bernhard, and Alexandre Ingels. Drafting the manuscript: Georges Mjaess, and Alexandre Ingels. Critical revision of the manuscript for scientific and factual content: Jean-Christophe Bernhard, Zine-Eddine Khene, Nicolas Doumerc, Christophe Vaessen, François Henon, Franck Bruyere, Martin Brenier, Bastien Parier, Simone Albisinni, and Alexandre Ingels. Statistical analysis: Georges Mjaess. Supervision: Jean-Christophe Bernhard, Zine-Eddine Khene, Nicolas Doumerc, Christophe Vaessen, François Henon, Franck Bruyere, Martin Brenier, Bastien Parier, Simone Albisinni, and Alexandre Ingels.

History

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Supplementary data

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