Original Article

Trifecta and pentafecta outcomes following robot-assisted partial nephrectomy for hilar versus nonhilar tumors: A propensity-matched analysis

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ABSTRACT

Introduction: Hilar tumors are a unique subset of complex renal masses posing a potential surgical challenge during partial nephrectomy. The outcomes of hilar masses have not been compared to non-hilar renal masses of similar RENAL nephrometry score (RNS). In this study, we analyzed the outcomes of hilar versus nonhilar masses after a propensity score matching.

Methods: Prospectively maintained database of patients who underwent robot assisted PN between November 2014 and December 2018 was abstracted for hilar and nonhilar tumors. We performed propensity matching for baseline variables such as age, sex, body mass index, comorbidities, preoperative glomerular filtration rate, and RNS for each patient on the basis of propensity scores.

Results: We included 48 patients with hilar tumors and 153 with nonhilar tumors. On propensity matching, 41 patients were included in each group. The mean operative time (162.4 ± 48.9 min vs. 144.1 ± 38.8 min, $P = 0.48$), warm ischemia time (29.0 ± 8.8 min vs. 24.4 ± 8.2 min, $P = 0.12$), and the estimated blood loss (201.8 ± 184.7 ml vs. 150.6 ± 160.5 ml, $P = 0.37$) were not significantly different between the hilar and the nonhilar groups. Trifecta was achieved in only 14/41 (34.1%) of the patients in the hilar group as compared to 24/41 (58.5%) in the nonhilar group ($P = 0.027$). Logistic regression analysis identified that hilar location of the tumors was not an independent predictor of overall complications (OR 6.37, confidence interval [CI] 0.5–69.4, $P = 0.4$), trifecta (OR 0.38, CI 0.14–1.0, $P = 0.051$), and pentafecta outcomes (OR 0.4, CI 0.1–1.51, $P = 0.17$).

Conclusions: Hilar location was associated with poorer trifecta outcomes compared to the nonhilar tumors. However, hilar location *per se* was not an independent predictor of overall complications and trifecta and pentafecta outcomes.

INTRODUCTION

With the widespread availability of ultrasound, the occurrence of incidentally detected renal masses has increased. Incidentally detected masses are usually small and are amenable to partial nephrectomy (PN). With the availability of the robotic platform, complex lesions, which were previously treated with radical nephrectomy or by open PN, can now be dealt minimally invasively.[1] Enthusiasm to treat complex renal masses with PN rather than radical nephrectomy (RN) is due to the superior functional and similar oncological outcomes associated with the former technique.[2] Multiple scoring systems have been defined to determine the complexity of renal masses.[3] Hilar tumors are complex tumors situated in the vicinity or in relation to the renal artery or renal vein. They present a unique surgical challenge due to the

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proximity to vessels and the lack of renal parenchyma for closure after PN. Location at the hilum has been recognized as one of the important variables defining complexity in the RENAL nephrometry score (RNS) and arterial-based complexity score. Robotic platform with three-dimensional vision, 7° of motion, reduced tremors, and superior suturing capabilities is more suited for dealing with such complex masses. After the initial feasibility study by Rogers *et al*.,[4] various groups have published their experience with robot-assisted partial nephrectomy (RAPN) for hilar tumors. Hilar tumors tend to be larger in size and have a higher propensity of being T1b and T3 stage as compared to the nonhilar tumors.[5] Literature has not been consistent on the perioperative outcomes such as operative room time (OR time), warm ischemia time (WIT), estimated blood loss (EBL), blood transfusion, length of stay (LOS), overall complications, and margin positivity rate after RAPN for hilar masses. Eyraud *et al*.[6] in their retrospective review, reported longer operating time, longer WIT, and higher EBL but a similar need of blood transfusion, similar LOS, complication rate, and margin positivity rate for hilar tumors as compared to nonhilar tumors, whereas Dulabon *et al*.[7] noted a significant difference between the two groups only for WIT. In a similar study by Lu *et al*.,[8] the authors noted that the hilar tumors were associated with longer WIT and operating time. One major drawback of these studies has been a lack of matching for the baseline characters such as RNS which defines the complexity of a renal mass better than a hilar location alone.[6-8] Thus, with the present study, we intended to compare the perioperative and functional outcomes following RAPN in patients with hilar tumors with a propensity-matched nonhilar group.

METHODS

In this retrospective study, we reviewed our prospectively maintained robot-assisted PN database from November 2014 to December 2018. All the included patients had previously undergone routine evaluation including kidney and liver function tests, hemogram, coagulation profile, and a triphasic contrast-enhanced computerized tomography (CECT) scan prior to surgery. CECT scan data were reviewed to identify all the hilar tumors by two experienced urologists and help of a third urologist was sought in case of discrepancy.Hilar tumors were defined as tumors originating from the medial aspect of the kidney, abutting the renal vasculature and/or renal pelvis along with renal sinus infiltration as documented on the preoperative CECT scan and corroborated intraoperatively.[7] The study protocol was approved by the institute ethics committee. Informed written consent was obtained from all individual participants included in the study.

Demographic data

For every patient, baseline demographic data including age, gender, body mass index (BMI), medical comorbidities, immediate preoperative creatinine, and chronic kidney disease (CKD) stage according to estimated glomerular filtration rate (eGFR) calculated according to Cockcroft–Gault formula[9] were extracted.

Operative technique and variables considered

Our surgical technique and follow-up methods have been previously described.[1] All the surgeries were performed "on-clamp" and selective clamping or early declamping was not performed. All the tumors were excised with a rim of normal renal parenchyma. Duration of the surgery included time from the placement of surgical incision to the last wound closure. WIT was defined as time duration between application and removal of the renal artery clamp. EBL during each surgery was also noted and extracted for the final analysis.

Postoperative follow-up

Complications were determined as per the Clavien–Dindo classification[10] within a 30-day period. After discharge, the patients were followed up at 3 months with fresh creatinine to calculate eGFR at 3 months which was used to estimate the difference in the preoperative and the postoperative eGFR. eGFR was again calculated at 1-year follow-up. Two variables, i.e. CKD upstaging and 90% preservation of eGFR, were estimated by comparing the eGFR values at 1 year follow-up and the preoperative eGFR.

Pathological data

The histopathological data extracted were tumor size, stage according to 2009 version of tumor, node, and metastasis classification, histological subtype according to the World Health Organization classification 2009, nuclear grade according to the Fuhrman *et al*. classification,[11] and the surgical margin status.

Trifecta and pentafecta

Trifecta was calculated by including three variables, i.e., margin status (negative), WIT (<25 min), and complications as Clavien–Dindo classification[10] (II and below). We also calculated the pentafecta outcomes that additionally included chronic kidney disease upstaging at 3 months and 90% eGFR preservation at 1 year.

Statistical analysis

Categorical data were summarized as numbers and percentages and the continuous data were presented either as mean and standard deviation or median and range, where indicated. The statistical methods included Chi-square tests or Fisher's exact test for the categorical data. The normality of continuous data was first evaluated by Kolmogorov–Smirnov and Shapiro tests of normality. If the data were found to be normally distributed, then independent sample *t*-test, otherwise Kruskall–Wallis test was used for nonparameteric data. Propensity scores were

Table 1: Comparison of baseline, intraoperative, pathological, and postoperative characteristics prior and postpropensity matching

Variables	Prior to propensity matching			Post propensity matching		
	Hilar (*n*=48), *n* (%)	Nonhilar (*n*=153), *n* (%)	*P*	Hilar (*n*=41), *n* (%)	Nonhilar (*n*=41), *n* (%)	*P*
Age (years), mean±SD	49.4±12.9	51.9±12.7	0.243	50.4±12.7	51.5±11.7	1.000
Sex (male/female)	29/19	94/59	0.899	24/17	25/16	0.822
BMI (kg/m^2), mean±SD	24.7±3.3	25.5±3.2	0.156	24.9±3.3	24.4±3.0	0.377
Comorbidity						
Any	20 (41.6)	65 (42.4)	0.920	16 (39.0)	17 (41.4)	0.822
DM	9 (18.7)	27 (17.6)	0.862	8 (19.5)	6 (14.6)	0.810
Hypertension	16 (33.3)	51 (33.7)	1.000	12 (29.2)	13 (31.7)	0.557
Laterality						
Right	22 (45.8)	82 (53.6)	0.348	19 (46.3)	23 (56.1)	0.377
Left	26 (54.2)	71 (46.4)		22 (53.7)	18 (43.9)	
CKD staging preoperatively						
I	32 (66.6)	89 (58.1)	0.492	26 (63.4)	21 (51.2)	0.307
II	12 (25)	51 (33.3)		11 (26.8)	15 (43.7)	
III	4 (8.3)	12 (7.8)		4 (9.7)	4 (9.7)	
IV	0	1 (0.6)		0	1 (2.4)	
Tumor size (cm), mean±SD	4.7±1.7	3.7±1.4	0.002	4.4±16	3.5±1.5	0.015
CKD upstaging (%)	13 (27)	31 (20.2)	0.319	12 (29.2)	11 (26.8)	0.806
Change in eGFR (ml/min), mean±SD	−8.6±23.7	−9.4±25.3	0841	−10.7±22.7	−7.4±16.5	1.000
Preoperative creatinine (ml/min), mean±SD	0.87±0.33	0.86±0.28	0.815	0.88±0.3	0.91±0.4	0.506
Preoperative eGFR (mean±SD)	101.5±39	103.9±38.4	0.713	100.8±41.8	92.3±28.0	1.000
WIT (min), mean±SD	28.8±8.3	23.9±9.1	0.000	29.0±8.9	24.4±8.2	0.122
WIT <25 min	16 (33.3)	95 (62.1)	0.000	14 (34.1)	24 (58.5)	0.027
OR time (min) mean±SD	166.2±51	144.7±44.7	0.136	162.4±48.9	144.1±38.8	0.485
Estimated blood loss (ml), mean±SD	201.5±175	152.6±170.7	0.019	201.8±184.7	150.6±160.5	0.372
90% eGFR preserved at 1 year	28 (58.3)	78 (50.9)	0.373	22 (53.6)	22 (53.6)	1.000
Fuhrman grade (*n*=162)	35	127		31	35	
1	23 (65.7)	78 (61.4)	0.174	20 (64.5)	21 (60)	0.471
2	9 (25.7)	45 (35.4)		8 (25.8)	13 (37.1)	
3	2 (5.7)	4 (3.1)		2 (6.4)	1 (2.8)	
4	1 (2.8)	0		1 (3.2)	0	
High-grade Fuhrman (Grade 3 and 4)	3 (7.8)	4 (3)	0.187	3 (9.6)	1 (2.8)	0.616
Histopathology						
Benign versus malignant	5/43	12/141	0.576	3/38	4/37	1.000
Clear cell	35 (81.4)	126 (89.3)	0.167	31 (81.5)	34 (91.9)	0.309
Nonclear cell	8 (18.6)	15 (10.7)		7 (18.5)	3 (8.1)	
T stage						
1a	12 (25)	66 (43.1)	0.008	12 (29.2)	22 (53.6)	0.167
1b	22 (45.8)	67 (43.7)		21 (60)	14 (34.1)	
2a	4 (8.3)	9 (5.8)		1 (3.2)	2 (6.4)	
2b	2 (4.1)	0		2 (6.4)	0	
3a	2 (4.1)	0		1 (3.2)	0	
Renal score (mean±SD)	8.2±1.7	6.8±2	0.001	7.9±1.7	7.8±1.7	0.823
Renal score risk stratification						
Low (4-6)	8 (16.6)	75 (49)	0.000	8 (25.8)	9 (21.9)	0.962
Intermediate (7-9)	28 (58.3)	57 (37.2)		26 (63.4)	25 (60.9)	
High (10-12)	12 (25)	21 (13.7)		7 (17.0)	7 (17.0)	
Margin positivity (%)	3 (6.25)	2 (1.3)	0.089	3 (7.3)	1 (2.4)	0.616
Hospital stay (mean±SD)	5.8±2.9	6.1±3.1	0.619	5.9±3.0	6.0±3.4	1.00
Need for blood transfusion (%)	5 (10.4)	5 (3.2)	0.047	4 (9.7)	1 (2.4)	0.359
Overall complications (%)	7 (14.5)	10 (6.5)	0.08	5 (12.1)	1 (2.4)	0.201
Trifecta (%)	16 (33.3)	90 (58.8)	0.002	14 (34.1)	24 (58.5)	0.027
Pentafecta (%)	7 (14.5)	44 (28.7)	0.049	5 (12.1)	11 (26.8)	0.09

BMI=Body mass index, DM=Diabetes mellitus, CKD=Chronic kidney disease, eGFR=Estimated glomerular filtration rate, WIT=Warm ischemia time, OR=Operative room, SD=Standard deviation

calculated for each patient using age, sex, comorbidity, BMI, preoperative GFR, and RNS as the covariates and trifecta as the outcome. Then, 1:1 matching was performed without replacements for each patient on the basis of propensity scores obtained with a caliper of 0.01. All the statistical tests were two sided and performed with a significance level $P < 0.05$. All the statistical analyses were conducted using SPSS version 23 (IBM corporation, New York, USA) and Stata (version 16; StataCorp, College Station, TX, USA).[12]

RESULTS

From December 2014 to December 2018, a total of 221 patients underwent RAPN at our institute. Out of these 221 patients, 20 patients were excluded and 201 patients were included in the final analysis. Of the excluded 20 patients, 5 were excluded due to bilateral renal masses, 1 with mass in transplanted kidney, and 14 patients with incomplete follow-up data. There were a total of 48 patients with hilar tumors and 153 with nonhilar tumors. Overall, the median follow-up was 38 months (range: 18–48 months). Both the groups compared well for the baseline demographic characteristics such as age, sex, laterality, BMI, preoperative eGFR, CKD staging, and preoperative creatinine. However, RNS was significantly higher in the hilar group (8.2 ± 1.7 vs. 6.8 ± 2, $P = 0.001$). Pre-matching data revealed significant differences between the two groups for T stage of the tumor, tumor size, EBL, WIT, WIT < 25, need for blood transfusion, trifecta, and pentafecta outcomes [Table 1]. Hilar group was associated with larger tumor size (4.7 ± 1.7 vs. 3.7 ± 1.4, $P = 0.002$), higher WIT (28.8 ± 8.3 vs. 23.9 ± 9.1, $P = 0.000$), higher EBL (201.5 ± 175 152.6 ± 170.7, $P = 0.019$), higher need for blood transfusion (10.4% vs. 3.2%, $P = 0.047$), lower rates of trifecta (33.3% vs. 58.8%, $P = 0.002$), and pentafecta outcomes (14.5% vs. 28.7%, $P = 0.049$) [Table 1]. However, the two groups were not different for other variables such as the number of patients with CKD upstaging, change in eGFR, OR time, 90% eGFR preserved at 1 year, Fuhrman grade, incidence of clear cell carcinoma, incidence of benign or malignant tumors, margin positivity, LOS, and the overall complication rate. After performing the propensity matching for age, sex, comorbidity, BMI, preoperative GFR, and RNS, 41 patients were analyzed in each group. Seven patients in the hilar group were excluded since RNS match was not found in the nonhilar group. The two groups were statistically different only for WIT <25 min, tumor size, and the trifecta outcomes with the results favoring the nonhilar tumors [Table 1]. The mean operative time, WIT, EBL, and the need for blood transfusions were not significantly different between the two groups. Trifecta was achieved in only 14/41 (34.1%) patients in the hilar group as compared to 24/41 (58.5%) in the nonhilar group, which was statistically significant ($P = 0.027$). On logistic regression analysis in the postmatching data to identify the predictors of complications (Clavien–Dindo Grade 2 or more), trifecta, and pentafecta, hilar location of the tumors was not found to be an independent predictor of overall complications (OR: 6.37, confidence interval [CI] 0.5–69.4, $P = 0.4$), trifecta (OR 0.38, CI 0.14–1.0, $P = 0.051$), or the pentafecta outcomes (OR: 0.4, CI 0.1–1.51, $P = 0.17$) [Table 2]. There was no peri-operative mortality in either of the groups. Overall, two patients (one in each group) who had positive surgical margins developed local recurrence during the period of the study.

DISCUSSION

PN in hilar tumors, a unique subset of complex masses, is challenging due to the close proximity to the major vessels and the unavailability of overlying renal parenchyma for closure. Furthermore, the hilar tumors have been reported to be larger in size, are associated with higher complexity scores,[13] are more likely to undergo RN[13] and have higher local recurrence rates.[14] With this study, we intended to compare the perioperative and functional outcomes in patients with hilar tumors with their propensity-matched group of nonhilar tumors.

In our study cohort, WIT, need for blood transfusion, and EBL were significantly higher for the hilar group prior to matching. After propensity matching, we noted comparable OR time, WIT, EBL, and the need for blood transfusion between the hilar and the nonhilar tumors. We compared our data set with the previously reported studies of RAPN in hilar tumors. Eyraud *et al.*,[6] in their retrospective review, reported longer duration of surgery, longer WIT, and higher EBL for hilar tumors, Dulabon *et al.*[7] noted longer WIT for hilar tumors and Lu *et al.*[8] noted that hilar tumors were associated with longer WIT and OR time [Table 3]. However, none of the studies had performed propensity matching for the baseline variables and most importantly for the complexity of the tumor (RNS). Hilar tumor location was also not found to be a predictor of the overall complications.

Regarding the pathological variables, our results are consistent with the previous studies. We did not find a difference between the two groups for the frequency of benign or malignant lesions, Fuhrman grade, nonclear cell tumors, or the margin positivity rate.[13] Tumor size was

Table 2: Multivariate logistic regression analysis to identify predictors of trifecta, pentafecta, and overall complications

Complications (CD≥2)	OR	Lower limit-upper limit of CI	*P*	Trifecta (OR)	Lower limit-upper limit of CI	*P*	Pentafecta (OR)	Lower limit–upper limit of CI	*P*
Age	1.01	0.93-1.10	0.718	1.03	0.99-1.08	0.157	0.99	0.94-1.06	0.946
BMI	1.19	0.88-1.62	0.245	0.89	0.75-1.04	0.138	1.04	0.85-1.28	0.66
Comorbidity	0.67	0.09-4.73	0.691	0.69	0.23-2.06	0.508	0.81	0.19-3.48	0.777
eGFR preoperative	0.98	0.94-1.01	0.307	1.01	0.99-1.02	0.282	0.97	0.95-1.00	0.029
Hilar versus nonhilar	6.37	0.58-69.4	0.129	0.38	0.14-1.00	0.051	0.40	0.11-1.51	0.176
Tumor size	0.88	0.43-1.79	0.732	0.94	0.67-1.33	0.728	0.92	0.59-1.45	0.738
Renal score	1.31	0.64-2.69	0.451	0.88	0.64-1.22	0.453	0.79	0.54-1.18	0.252

CD=Clavien–Dindo, BMI=Body mass index, eGFR=Estimated glomerular filtration rate, CI=Confidence interval, OR=Odds ratio

Table 3: Comparison of previously published studies comparing hilar with nonhilar group for robotic partial nephrectomy

Variables	Correa *et al.*[13]			Lu *et al.*[8]			Dulabon *et al.*[7]			Eyraud *et al.*[6]			Our data*		
	Hilar (*n*=226)	Nonhilar (*n*=1098)	*P*	Hilar (*n*=30)	Nonhilar (*n*=170)	*P*	Hilar (*n*=41)	Nonhilar (*n*=405)	*P*	Hilar *n*=70)	Nonhilar (*n*=294)	*P*	Hilar (*n*=41)	Nonhilar (*n*=41)	*P*
Age (years) (mean±SD), median (range)	60 (27-87)	60 (20-89)	0.986	52.4±15.3	58.0±13.5	0.04	59.3±12.8	60.0±11.3	0.72	58 (48-67)	59 (52-67)	0.23	50.4±12.7	51.5±11.7	1.000
Sex (male/female)	140/86	705/393	0.520	14/16	99/71	0.239	29/12	233/172	0.10	45/25	170/124	0.32	24/17	25/16	0.822
BMI (kg/m^2) (mean±SD), median (range)	–	–	–	23.7±3.3	25.4±3.9	0.018	28.6±6.3	30.2±6.4	0.14	29.39 (25.7-32.7)	29.29 (26.18-34.3)	0.28	24.9±3.3	24.4±3.0	0.377
WIT (min) (mean±SD), median (range)	–	–	–	39.9±24.0	21.8±16.0	<0.001	26.3±7.4	19.6±10.0	<0.001	27 (21.7-31.2)	17 (13-22)	<0.001	29.0±8.9	24.4±8.2	0.122
OR time (min) (mean±SD), median (range)	192 (20-550)	177 (60-486)	<0.01	293.6±87.6	240.5±80.1	0.001	194±55	187±64	0.52	210 (180-270)	180 (150-210)	<0.001	162.4±48.9	144.1±38.8	0.485
Estimated blood loss (ml) (mean±SD), median (range)	177 (20-1800)	178 (20-2800)	0.697	418.7±452.4	305.8±336.9	0.285	262±248	208±217	0.14	250 (100-400)	200 (100-300)	0.041	201.8±184.7	150.6±160.5	0.372
Tumor size (cm) (mean±SD) median (range)	3.9±1.6	3.4±1.5	<0.01	4.8±2.0	3.7±1.8	0.009	3.46±1.35	2.88±1.53	0.02	3.9 (2.8–5)	2.6 (1.9-3.6)	<0.001	4.4±16	3.5±1.5	0.015
Histopathology															
Benign	29	191	NA	-	-	-	4	105		-	-	-	3/38	4/37	1.000
Clear cell	157	630	0.01				29	193	NA				31	34	0.309
Nonclear cell	40	277					7	98					7	3	
T stage															
1a	-	-	-	9	93	0.266	23	248	<0.001	26	160	0.49	12	22	0.167
1b				5	20		6	36		19	4		21	14	
2a				0	1		1	3					1	2	
2b										1	30		2	0	
3a				2	10		5	8		7	11		1	0	
3b							2	1							
Renal score (mean±SD)	-	-	-	9.0±1.2	7.4±1.7	<0.001	-	-	-	-	-	-	7.9±1.7	7.8±1.7	0.823
Renal risk stratification (%)															
Low	8.8	34.9	<0.01	-	-	-	-	-	-	0	49.7	<0.001	8	9	0.962
Intermediate	59.3	52.4	0.057							41.4	44.9		26	25	
High	31.9	12.8	<0.01							58.6	5.4		7	7	
Margin positivity (%)	-	-		5.3	0	0.123	2.4	1.5	0.22	1.4	3	0.45	3	1	0.616
Hospital stay (mean±SD), median (range)	Median 3	Median 3	0.756	6.0±1.8	5.6±1.7	0.259	2.94±2.27	2.87±1.45	0.78	-	-	-	5.9±3.0	6.0±3.4	1.00
Need for blood transfusion (%)	-	-	-	20	8.2	0.089	2.4	4.2	0.22	12.8	8.8	0.34	4	1	0.359
Complications (%)	-	-	-	Minor: 23.3 Major: 0	Minor: 12.4 Major: 2.4	0.278	-	-	-	Overall 33	Overall 22.5	0.10	5	1	0.201

*Propensity matched data. BMI=Body mass index, WIT=Warm ischemia time, OR=Operative room, SD=Standard deviation, NA=Not applicable

larger for the hilar tumors which is consistent with the previous studies.[7,8,13] Hilar tumors have been reported to have a higher T stage by Dulabon *et al*.[7] but not by Lu *et al*.[8] and Eyraud *et al*.[6] Our unmatched data showed that hilar tumors had a higher T stage.

In this study, we did not note a significant difference between the two groups for various functional assessment variables such as the eGFR difference, CKD upstaging, and 90% eGFR preservation at 1 year. Lu *et al*., as well in their study, did not note any significant difference between the two groups for a change in the eGFR at 6 months and 1 year. Similarly, in a study comparing hilar versus nonhilar groups for laparoscopic PN, the authors did not find a difference between the two groups for eGFR at 6 months.[15] Eyraud *et al*. also did not find a difference in the rates of CKD upstaging and eGFR change. Thus, despite the overall complexity associated with hilar tumors leading to a prolonged WIT and a higher EBL, as seen in some studies, the prospects of renal function recovery are similar to the nonhilar group. These finding suggests that once a successful PN surgery is performed, which has become possible with robotic assistance, the complexity *per se* will not affect the renal functional outcomes.

Trifecta (WIT <25 min, negative surgical margins, and no grade 2 or higher complications) outcomes were found to be significantly poor in the hilar group. This seems to be primarily driven by WIT <25 min variable of the trifecta. The increase in WIT could echo the difficulty in dissection, resection, and subsequent renorrhaphy associated with the hilar tumors. However on logistic regression analysis, hilar location of tumors could not reach statistical significance for predicting the trifecta outcomes (OR 0.38 [0.14, 1] $P = 0.051$). In contrast to trifecta outcomes, pentafecta outcomes were similar in the two groups and the hilar location was not an independent predictor of the pentafecta outcomes. This could be explained by a similar recovery of the renal parenchymal function at 1 year. We could not find a study comparing the pentafecta and trifecta outcomes for RAPN in hilar versus nonhilar tumors in the literature. However, a study by Sagalovich *et al*.[16] compared open versus RAPN and found similar rates of trifecta outcomes for both the groups.

There are certain limitations of this study; first, being retrospective in nature, it is susceptible to selection bias; however, we included consecutive patients in this study. Second, all the surgeries in this study were performed by experienced laparoscopic and robotic surgeons, thus the results cannot be generalized. Third, there could be a bias in the selection of the patients into the hilar group, as the definition is subjective with intra-observer variability. However, we tried to reduce the same by involving two experienced urologists to review the imaging and in case of discrepancy, help of a third urologist was sought. Fourth, the calculation of eGFR was based on Cockgroft–Gault equation which tends to overestimate and underestimate GFR in a given situation. GFR obtained from radioisotope renography would have been an ideal solution to this problem.

CONCLUSIONS

In this propensity-matched analysis, hilar location was associated with poor trifecta outcomes compared to nonhilar tumors in patients undergoing RAPN. However, the hilar location *per se* was not an independent predictor of overall complications and the trifecta and pentafecta outcomes.

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