Robot-assisted partial nephrectomy in cystic tumours: Analysis of the Vattikuti Global Quality Initiative in Robotic Urologic Surgery (GQI-RUS) database

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Robot-assisted partial nephrectomy in cystic tumours: analysis of the Vattikuti Global Quality Initiative in Robotic Urologic Surgery (GQI-RUS) database

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Abstract

Objective

To evaluate the outcomes of robot-assisted partial nephrectomy (RAPN) in cystic tumours, analysing a large, multi-institutional, retrospective series of RAPN, as limited data are available about the outcome of RAPN in cystic tumours.

Patients and Methods

We evaluated 465 patients who received RAPN for either cystic or solid tumours from 2010 to 2013 and included in the multi-institutional, retrospective Vattikuti Global Quality Initiative in Robotic Urologic Surgery (GQI-RUS) database. Univariable and multivariable linear and logistic regression models addressed the association of cystic tumours with perioperative outcomes.

Results

In all, 54 (12%) tumours were cystic. Cystic tumours were associated with significantly lower operative time (t −3.9; $P < 0.001$), once adjusted for the effect of covariates, whereas blood loss and warm ischaemia time were similar. Postoperative any grade complications were recorded in 66 solid (16%) and nine cystic (17%) tumours ($P = 0.08$). In multivariable analysis, cystic tumours were not associated with a significantly lower risk of any grade postoperative complications [odds ratio (OR) 0.9; $P = 0.8$]. Similarly, presence of tumours with cystic features was not associated with a significantly different risk of high-grade postoperative complications (OR 2.2; $P = 0.1$). Prevalence of cancer histology and positive surgical margin rates were similar in cystic and solid tumours. Cystic tumours were not associated with significantly different postoperative estimated glomerular filtration rate (t 0.4; $P = 0.7$), once adjusted for the effect of covariates.

Conclusions

RAPN can be performed in cystic renal tumours with perioperative, pathological, and functional outcomes similar to those achievable in solid tumours.

Introduction

Partial nephrectomy (PN) is considered the standard surgical treatment for small renal masses [1, 2]. In the last decade, robot-assisted PN (RAPN) has gained in popularity and been increasingly applied, with convincing results [3, 4].

Up to 20% of the renal masses suitable for PN contain cystic components [5, 6]. Cystic lesions may represent a particular challenge during RAPN due to the risk of rupture of the cystic wall. The available literature on RAPN performed for cystic renal masses is indeed very limited. Recently, Akca et al. [7] reported the experience of a single tertiary USA referral centre reporting good outcomes for RAPN in cystic tumours, comparable to solid lesions. However, the paper reports the experience of a single, referral, high-volume centre expert in dealing with RAPN and the reproducibility of those findings is other centres has not been confirmed. Consequently, the purpose of the present study was to report outcomes of RAPN in a large, multi-institutional, retrospective series of RAPN.

Patients and Methods

The Vattikuti Global Quality Initiative in Robotic Urologic Surgery (GQI-RUS) database is an Institutional Review Board-approved database including data of 10 worldwide centres. A computerised databank was generated for data transfer. After combining the data sets, reports were generated for each variable to identify data inconsistencies and other data integrity problems. Through regular communication with all sites, resolution of all identified anomalies was achieved before analysis. Before final analysis, the database was frozen, and the final data set was produced for the current analysis.

The GQI-RUS database comprised 1 045 patients who underwent RAPN between 2010 and 2013 for clinical N0M0 renal tumours. After exclusion of patients where the Preoperative Aspects and Dimensions Used for an Anatomical (PADUA)-score classification [8] was not available (580 patients), the 465 remaining patients were the subjects of the present analysis.

Charlson comorbidity index was adopted to report patient comorbidity [9]. The PADUA score was adopted to report anatomical characteristics of the renal tumour [8]. Renal function was assessed by calculating the estimated GFR (eGFR) using the modification of diet in renal disease formula [10].

Cystic renal masses were diagnosed on cross-sectional imaging (CT or MRI; Fig. 1). Surgery was performed by several surgeons according to the standard criteria for RAPN, i.e. complete resection of the tumour and a border of healthy parenchyma. Lymphadenectomy was not routinely performed.

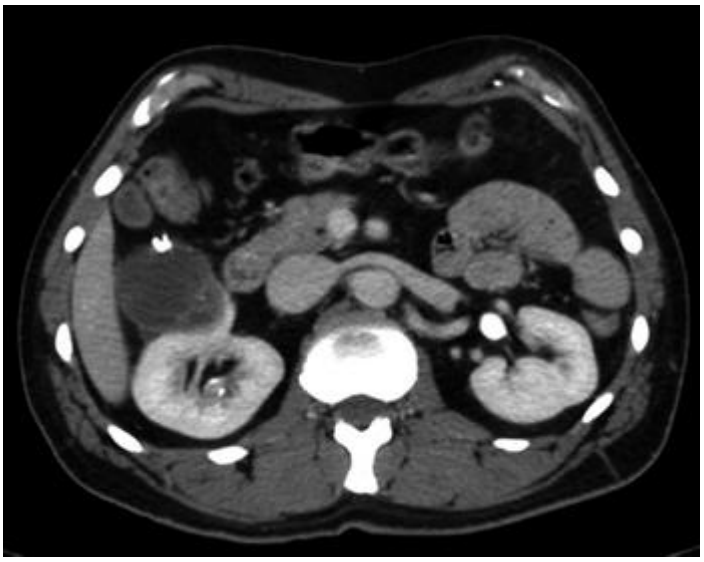

Figure 1.

- Open in figure viewer

CT scan of a 5-cm cystic renal mass, with irregular thickness and some calcification in cystic wall. Note contralateral healthy kidney, with regular excretion of the contrast in the renal pelvis.

Pathological Evaluation

All surgical specimens were processed according to standard pathological procedures at each institution. Tumours were staged according to the 2010 American Joint Committee on Cancer–Union Internationale Contre le Cancer TNM classification [11]. Histological subtype was defined according to the Heidelberg classification [12]. Tumour grading was assessed according to the Fuhrman system [13]. Positive surgical margin (PSM) status was defined as the presence of malignant tissue on the inked surface of the tumour on final pathological assessment.

Follow-up Regimen

Patients were generally assessed every 3–6 months for the first year after RAPN, and annually thereafter. Follow-up consisted of a history, physical examination, routine blood work and serum chemistry studies, chest and abdominal imaging, as per urologist preference.

Statistical Analysis

The chi-square test was used to evaluate the association between categorical variables. Differences in variables with a continuous distribution across dichotomous categories were assessed using the Mann–Whitney *U*-test. Univariable and multivariable linear and logistic regression models addressed the association of cystic feature with operative time, warm ischaemia time (WIT), estimated blood loss (EBL), intraoperative and postoperative any grade and high-grade complications, pathological outcome (presence of malignant disease and PSM), and eGFR after RAPN. T statistics and odds ratios (ORs) with 95% CIs were used to report regression analyses. All multivariable regression analyses were adjusted for age, gender, Charlson comorbidity index, indication for RAPN, and PADUA-score risk group. Subgroup analyses were performed in the different PADUA-score risk groups adjusting for the other covariates. Statistical significance in this study was set as $P \leq 0.05$. All reported *P* values are two-sided. Analyses were performed with SPSS vers 20.0 (SPSS Inc, Chicago, IL, USA).

Results

In all, 54 (12%) tumours were cystic. Table 1 shows the association between the presence of a cystic renal mass with clinical features in this cohort. Patient age, prevalence of imperative indication for RAPN, and PADUA-score risk group were significantly different in cystic and solid tumours (all $P < 0.05$).

Table 1. Association of the presence of cystic tumours with clinical, intraoperative, postoperative and pathological characteristics of 465 patients treated with RAPN

Variable	All patients	Cystic tumours	Solid tumours	*P*
Number of patients (%)	465 (100)	54 (12)	411 (88)	

1. *Data missing in 34 cases (7%); †data missing in six cases (1.6%) of the 370 with RCC; ‡data missing in six cases (4.3%) of the 370 with RCC.

Variable	All patients	Cystic tumours	Solid tumours	*P*
Male gender, *n* (%)	317 (68.2)	36 (66.7)	281 (68.4)	0.801
Median (IQR)				
Age, years	59 (50–67)	62 (54.7–71.2)	58 (49–66)	0.035
Charlson comorbidity index	1 (0–3)	2 (0–3)	1 (0–3)	0.322
Clinical tumour size, mm	32 (23–40)	34.5 (21–50.2)	32 (23–40)	0.184
N (%)				
Imperative indication to RAPN,	12 (2.6)	4 (7.4)	8 (1.9)	0.017
Symptoms at presentation	53 (11.4)	10 (18.5)	43 (10.5)	0.212
Clinical T stage				
T1a	358 (77)	37 (68.5)	321 (78.1)	
T1b	100 (21.5)	15 (27.8)	85 (20.7)	
T2a	3 (0.6)	1 (1.9)	2 (0.5)	0.185
T2b	2 (0.4)	1 (1.9)	1 (0.2)	
T3	2 (0.4)	0	2 (0.5)	
PADUA-score risk group				
Low	214 (46)	13 (24.1)	201 (48.9)	
Intermediate	146 (31.4)	28 (51.9)	118 (28.7)	0.001
High	105 (22.6)	13 (24.1)	92 (22.4)	
No clamping of the renal artery*	13 (3)	2 (4.1)	11 (2.8)	0.626
Median (IQR)				
Operative time, min	150 (120–200)	120 (105–150)	160 (120–210)	<0.001
EBL, mL	100 (60–200)	150 (80–250)	100 (60–200)	0.482
WIT, min	17 (13–21)	18 (13–20.5)	17 (13–21)	0.812
N (%)				
Intraoperative complications	24 (5.2)	0	24 (5.8)	0.068
Postoperative complications				
Grade 0	390 (83.9)	45 (83.3)	345 (83.9)	
Grade 1	28 (6)	0	28 (6.8)	
Grade 2	24 (5.2)	3 (5.6)	21 (5.1)	0.077
Grade 3	18 (3.9)	4 (7.4)	14 (3.4)	
Grade 4	3 (0.6)	1 (1.9)	2 (0.5)	
Grade 5	2 (0.4)	1 (1.9)	1 (0.2)	
Median (IQR)				
Length of stay, days	5 (4–6)	5 (4–7)	5 (4–6)	0.076
Pathological tumour size, mm	30 (20–40)	29 (17–40)	30 (21–40)	0.651
N (%)				
Histology				
Benign	95 (20.4)	11 (20.4)	84 (20.4)	
Clear cell RCC	282 (60.6)	31 (57.4)	251 (61.1)	0.418
Papillary RCC	56 (12)	10 (18.5)	46 (11.2)	
Chromophobe RCC	26 (5.6)	1 (1.9)	25 (6.1)	

Variable	All patients	Cystic tumours	Solid tumours	*P*
Unclassified RCC	6 (1.3)	1 (1.9)	5 (1.2)	
Pathological T stage†				
T1a	274 (75.3)	33 (76.7)	241 (75.1)	0.945
T1b	60 (16.5)	6 (14)	54 (16.8)	
T2a	3 (0.8)	0	3 (0.9)	
T3	27 (4.1)	4 (9.3)	23 (7.2)	
Fuhrman nuclear grade‡				
1	74 (20.9)	14 (33.3)	60 (19.2)	0.127
2	246 (69.5)	23 (54.8)	232 (71.5)	
3	32 (9)	5 (11.9)	27 (8.7)	
4	2 (0.6)	0	2 (0.6)	
PSM	21 (4.5)	4 (7.4)	17 (4.2)	0.281
Median (IQR) eGFR, mL/min/1.73 m^2				
Preoperative	81 (69–94)	79 (66–94)	81 (69–95)	0.362
At follow-up	78 (64–87)	76 (65–80)	78 (63–88)	0.345

Intraoperative Variables

Cystic tumours were associated with significantly lower operative time (t −3.9; $P < 0.001$), once adjusted for the effect of covariates. Stratifying by PADUA score, such an association was evident in intermediate (t −3.1; $P = 0.02$), and high (t −2.2; $P = 0.03$) PADUA-score risk groups, but not in the low-risk category. Conversely, cystic tumours were not associated with differences in EBL and WIT, either in the full cohort or when stratifying by PADUA-score risk groups. There were no cases of cystic wall rupture.

Postoperative Variables

Postoperative complications of any grade were recorded in 66 solid (16%) and nine cystic (17%) tumours ($P = 0.08$). In univariable regression analysis, cystic tumours were not associated with a significantly different risk of any grade of postoperative complication (OR 1.1; $P = 0.9$). In multivariable analysis, presence of tumours with cystic features was not associated with a significantly lower risk of any grade postoperative complications (OR 0.9; $P = 0.8$) once adjusted for covariates. Also, stratifying by PADUA-score risk group, any correlation among cystic tumours and any grade of postoperative complications failed to be demonstrated.

Grade 3 to 5 postoperative complications occurred in 17 solid (4%) and six cystic (11%) tumours ($P = 0.03$). In univariable regression analysis, cystic tumours were associated with a significantly higher risk of high-grade postoperative complications (OR 2.9; $P = 0.03$). In multivariable analysis, presence of tumours with cystic features was not associated with a significantly different risk of high-grade postoperative complications (OR 2.2; $P = 0.1$). Also stratifying by PADUA-score risk group, any correlation among cystic tumours and high-grade postoperative complications failed to be demonstrated.

Pathological Outcomes

The prevalence of RCC was similar in both groups (79.6% vs 79.6%; *P* = 0.991). In univariable regression analysis, cystic tumours were not associated with a significantly different risk of a malignant histology (OR 1.0; *P* = 0.99). In multivariable analysis, presence of tumours with cystic features was not associated with a significantly higher risk of malignant histology (OR 0.8; *P* = 0.7). Also stratifying by PADUA-score risk group, any correlation among cystic tumours and malignant histology failed to be demonstrated.

PSMs were identified in 17 of 409 (4.2%) solid RCCs and in four of 54 (7.4%) RCCs with a cystic component (*P* = 0.281). In univariable regression analysis, cystic tumours were not associated with a significantly higher risk of PSM (OR 1.0; *P* = 0.99). Similarly, in multivariable analysis, cystic tumours were not associated with a significantly higher risk of PSM (OR 1.5; *P* = 0.5). Similar results were seen when stratifying by PADUA-score risk group.

Postoperative Renal Function

The median (interquartile range, IQR) baseline eGFR was 79 (66–94) and 81 (69–95) mL/min/1.73 m^2 in cystic and solid tumours, respectively (*P* = 0.362). The median (IQR) follow-up duration was 10 (3–24) and 6 (3–19) months in the cystic and solid tumour groups, respectively (*P* = 0.364). At follow-up, the median (IQR) postoperative eGFR was 76 (65–80) mL/min/1.73 m^2 in those with cystic tumours (*P* = 0.878) and 78 (63–88) mL/min/1.73 m^2 in those with solid tumours (*P* = 0.345). The cystic tumours were not associated with significantly different postoperative eGFR (*t* 0.4; *P* = 0.7), once adjusted for the effect of covariates. Also, when stratifying by PADUA score, no difference was seen in any risk group.

Oncological Outcome

At follow-up, we identified one local recurrence (1.9%) in the cystic group and 10 (1.8%) in the solid tumour group (*P* = 0.425). None of the patients with PSM had recurred by the most recent follow-up. The limited number of events precludes further predictive analysis.

Discussion

In the present study, we analysed the outcomes of RAPN in cystic renal masses, evaluating the GQI-RUS database, a large retrospective database of RAPN performed in several institutions worldwide. We demonstrated that, even in this special setting of patients; RAPN is associated with favourable intra- and perioperative outcomes, which indeed were mostly similar to those achievable in solid tumours for most of the intraoperative parameters, postoperative complications, pathological and functional results.

Although up to 20% of the tumours included in PN series have cystic components [5, 6], the peculiarities of RAPN in cystic lesions have undergone limited evaluation in the currently available literature. Specifically, due to the risk of cystic wall rupture during tumour resection and the subsequent risk of local tumour spillage, handling of cystic tumours may require special care and skills. Specifically, Akca et al. [7] reported on 55 cystic tumours treated with RAPN at the Cleveland Clinic Foundation from 2007 and 2014. The perioperative and postoperative results of RAPN in that setting were compared with a contemporary matched cohort of patients treated with RAPN at the same centre for solid tumours. Finally, the authors showed that intraoperative variables (operating time, EBL, WIT, and complications), postoperative complications, and eGFR decline were similar in the two groups [7]. Notably, the prevalence of RCC was higher in the solid tumour group, due to the presence of 18 benign cysts. Although large, and homogeneous, the above

mentioned results represent the outcome of RAPN as performed by three high-volume surgeons at a tertiary referral centre. For that reason, we decided to analyse our multi-institutional RAPN database to assess the outcome of RAPN in cystic lesions. We have shown that RAPN in these patients was associated with outcomes that were similar to those of solid tumours. With the exception of operating time, which was indeed slightly shorter in cystic lesions once adjusted for covariates, all the other intraoperative (EBL, WIT, complications), postoperative (any grade complications and high-grade complications), pathological features (prevalence of malignant histology and PSMs), and functional outcomes were overlapping in cystic and solid lesions. Notably, we stratified our present results according to the anatomical characteristics of the tumours, as assessed by the PADUA score [8], in order to further assess the impact of the cystic component together with the other anatomical characteristics of the renal mass. Taken together, the data corroborate the concept that RAPN can be a safe and appropriate treatment in cases of cystic lesions whenever PN is indicated for surgeons with adequate experience in RAPN. Such findings are of special relevance due to the multi-institutional, multi-surgeon nature of the present series, suggesting reproducibility of the above mentioned findings in the hands of several surgeons and also outside of high-volume centres.

There are several limitations to our present study. First and foremost are the limitations inherent to retrospective analyses. Secondly, due to the lack of data on PADUA-score classification in several patients included in our database, we were obliged to limit the analyses to <50% of the cases included in the database. Consequently, the number of patients with cystic tumours was relatively low, which could have made some of our statistical analyses underpowered. However, we found that the relevance of the study would have been much higher stratifying all the outcomes by the anatomical tumour characteristics, as expressed by the PADUA score. Thirdly, the population in the present study underwent RAPN by multiple surgeons, and specimens were evaluated by multiple pathologists without slide review. However, all surgeons operated at selected centres with significant experience in robotic surgery, which might increase the external validity of the data, compared with the single-centre setting. Fourth, data on Bosniak classification was not available in our database and radiological revision of the preoperative imaging was not possible. Revision of the preoperative imaging could have minimised the risk of misdiagnosis of macroscopic poorly enhancing lesions and/or macroscopic tumour necrosis as cystic lesions, risk which indeed is present in our analyses. Finally, the limited number of disease recurrence available at the present follow-up prevented us from assessing the oncological efficacy of RAPN in cystic renal tumours.

In conclusion, the present analysis suggests that RAPN can be performed for cystic renal tumour with perioperative, pathological, and functional outcomes similar to those achievable in solid tumours. Consequently, cystic lesions should not represent a contraindication for RAPN.

Conflicts of Interest

Alex Mottrie: fees from Intuitive Surgical. Ben Challacombe: paid speaker for Intuitive Surgical. Rodney Abaza: grants and fees from Intuitive Surgical and Surgiquest. All the other authors have no conflicts of interest to disclose.

Abbreviations
EBL

estimated blood loss

eGFR

estimated GFR

GQI-RUS

Global Quality Initiative in Robotic Urologic Surgery

IQR

interquartile range

OR

odds ratio

PADUA

Preoperative Aspects and Dimensions Used for an Anatomical (score)

(RA)PN

(robot-assisted) partial nephrectomy

PSM

positive surgical margin

WIT

warm ischaemia time

Ancillary

Refer

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