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## What Is Better for Predicting Morbidity of Robotic Partial Nephrectomy—A Score or Your Clinical Judgement?

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**Keywords:** Partial nephrectomy; Robotic surgical procedures; Nephrometry scores; Complications; Visual analogue scale

### Abstract

**Background:** Little is known about the predictive value of surgeon's judgement to estimate perioperative outcomes following robotic partial nephrectomy (RPN).

**Objective:** To evaluate the accuracy of surgeon's intuition to estimate perioperative outcomes of patients undergoing RPN and compare its predictive value with that of objective scoring systems.

**Design, setting, and participants:** We prospectively analysed 100 consecutive patients who underwent RPN.

**Outcome measurements and statistical analysis:** RENAL, PADUA, and MAP scores were calculated based on preoperative imaging. The surgeon gave a subjective estimation of the technical difficulty and the risk of postoperative complications of RPN immediately before and after surgery using a visual analogue scale (VAS). Correlation between scores, VAS, estimated blood loss (EBL), operative time (OT), and warm ischaemia time (WIT) were examined. Logistic regression analyses were performed to identify the best predictors of overall complications. Receiver operating characteristic (ROC) curve analysis was used to assess the accuracy of VAS and scoring systems to predict trifecta achievement.

**Results and limitations:** RENAL, PADUA, and MAP scores significantly correlated with surgeon's pre- and postoperative VAS evaluation, with the RENAL score showing the strongest correlation ( $r = 0.49$  and  $r = 0.34$ , respectively). Pre- and postoperative VAS scores had the strongest correlation with EBL ( $r = 0.48$  and  $r = 0.59$ , respectively), OT ( $r = 0.44$  and  $r = 0.65$ , respectively), and WIT ( $r = 0.37$  and  $r = 0.47$ , respectively). In multivariate analysis adjusted for anticoagulant/antiplatelet treatment, body mass index, surgeon's experience, and Charlson comorbidity index, only surgeon's prediction could significantly predict overall complications (odds ratio = 5.42,  $p < 0.001$ ). Finally, surgeon's intuition was better to predict trifecta accomplishment than all radiological scores (ROC areas under the curves were 0.76 and 0.77 for pre- and postoperative VAS scores, respectively).

**Conclusions:** Surgeon's clinical assessment is a good predictor of perioperative outcomes of RPN and seems to perform better than conventional scores.

**Patient summary:** In this report, we found that surgeon's clinical feeling can better predict perioperative morbidity of robotic partial nephrectomy than conventional radiological scores.

## 1. Introduction

Partial nephrectomy (PN) is the standard treatment of small localised renal masses [1]. Over the last 10 yr, robotic PN (RPN) has been used increasingly because it provides optimal cancer control with lower morbidity than the open approach [2]. Robotic assistance has made tumour resection easier, but it remains a morbid intervention with complications that can occur in up to 30% of cases [3]. There have been many publications that evaluated predictors of complications after RPN. It has been shown that the morbidity of RPN could be driven by tumour complexity [4], tumour environment [5], patients' comorbidities [6], and centre/surgeon volume [7].

Radiological scores have been designed to provide objective information regarding surgical complexity [8]. Some of them focus on tumour anatomy (RENAL and PADUA scores are the most well known), while others evaluate tumour environment and particularly the presence of adherent perinephric fat (MAP score). These scores can assist the surgeon in the decision-making process and in planning the most appropriate surgical approach [9]. However, despite being widely reported in the urological literature, their applicability and reproducibility remain controversial [10–12].

Our objective was to evaluate the accuracy of surgeon's subjective intuition to estimate perioperative outcomes of patients undergoing RPN and compare its predictive value with that of objective scores that evaluate tumour complexity and the presence of adherent perinephric fat. We hypothesised that scoring systems would be more accurate than the surgeon's feeling.

## **2. Patients and methods**

### ***2.1. Study design and participants***

Following institutional review board approval, 100 consecutive patients undergoing RPN for a localised renal tumour at our institution were prospectively included from April 2016 to August 2017. All RPNs were performed by an expert surgeon (high experience) or a senior surgeon (medium experience) or by three fellows (low experience) under the supervision of the expert surgeon. In the operating room, the surgeons were asked to estimate the technical difficulty of RPN immediately before and after surgery using a visual analogue scale (VAS). The surgeon was asked to place the cursor on the scale according to the perceived difficulty of the operation, with 0 indicating absolutely no difficulty and 100 indicating extremely difficult operation. The surgeon could only see the side of the scale without graduation. The nurse recorded the corresponding number (between 0 and 100) without telling the surgeon. In addition, just before the case, the surgeon estimated the probability of occurrence of 30-d postoperative complications using a binary criterion (complication vs no complications; Fig. 1).

## **2.2. Score calculation**

Prior to surgery, preoperative computed tomography scans were prospectively and independently analysed by two physicians: one urologist (Z.K.) and one radiologist (C.R.). Both physicians were blinded to clinical information. In case of discordance, the opinion of a third reader (B.P.) was requested. RENAL [13], PADUA [14], and MAP [15] scores were calculated based on imaging studies.

## **2.3. Covariates**

Patient and tumour characteristics were prospectively collected in an electronic database. Demographics included age, gender, American Society of Anaesthesiologists

score, body mass index (BMI), anticoagulant/antiplatelet treatment, Charlson comorbidity index (CCI), Eastern Cooperative Oncology Group score, and surgeon's experience (subjectively categorised as high [ $>100$  cases], medium [50–100 cases], or low [ $<50$  cases]). Tumour characteristics included tumour size, tumour side, and presence of adherent perinephric fat. Pathological data included stage, surgical margins, and histological subtype.

#### ***2.4. Perioperative outcomes***

The following variables were collected: operative time (OT), warm ischaemia time (WIT), estimated blood loss (EBL), positive surgical margins, overall complication rate, major complication rate, and absolute change in estimated glomerular filtration rate (eGFR) calculated using the abbreviated Modification of Diet in Renal Disease formula. Postoperative complications were graded using the Clavien-Dindo classification [16]. Major complications were defined as a Clavien score of 3 or higher. All outcomes were recorded within 30 d after the procedure. Achievement of trifecta was defined as the combination of WIT  $<25$  min, negative surgical margins, and no perioperative complications [17].

#### ***2.5. Statistical analyses***

Descriptive statistics were reported as median and interquartile range (IQR) for continuous variables, and frequencies and percentages for categorical variables. Spearman's rank correlation coefficients were determined between continuously coded scores and quantitative perioperative outcomes. Four separate logistic regression models adjusted for anticoagulant/antiplatelet treatment, BMI, surgeon's experience, and

CCI were used to perform univariable and multivariable analyses to identify the best predictor of overall complications. Receiver operating characteristic curve analysis was used to assess the accuracy of each scoring system and surgeons' VAS score for predicting the trifecta achievement. Statistical analyses were performed using Stata 14.1 statistical software (Stata, College Station, TX, USA). All tests were two sided with a significance level at  $p < 0.05$ .

### **3. Results**

#### **3.1. Patient characteristics**

Patients' demographics, perioperative outcomes, and pathological data are listed in Table 1. Most patients were male (63%) with a median age of 59 yr. Median tumour size was 40 mm. Median blood loss, WIT, and OT were 270 ml, 18 min, and 140 min, respectively. There were six angiomyolipomas, 10 oncocytomas, and 84 renal cell carcinomas (RCCs). Pathological stages of RCCs were 69% pT1, 5% pT2, and 10% pT3. There were six cases of positive margin on final pathology. Postoperative complications were observed in 33 patients, including 11 major complications (Supplementary Table 1). Median hospital stay was 2 d (IQR: 1–3). Absolute change in eGFR was  $-2$  ml/min (IQR:  $-4$  to 0).

#### **3.2. Surgeons' clinical judgement and radiological score characteristics**

Table 2 details all scores and surgeon's VAS evaluations. Median RENAL, PADUA, and MAP scores were 8 (IQR: 6–10), 9 (IQR: 8–10), and 2 (IQR: 0–4), respectively. Pre- and postoperative VAS scores were 55 (IQR: 40–70) and 60 (IQR: 50–80), respectively.

Table 3 shows Spearman correlation coefficients between surgeon's VAS and radiological scores. All scores significantly correlated with pre- and postoperative VAS scores, but the strongest correlation was observed between preoperative VAS and RENAL scores ( $r = 0.49$ ;  $p < 0.001$ ).

### **3.3. Predictors of WIT, OT, and EBL**

Table 4 shows Spearman correlation rates between VAS scores, radiological scores, and OT-EBL-WIT (variables that we considered surrogates of perioperative morbidity). Pre- and postoperative VAS scores had a significant correlation with all three parameters: EBL ( $r = 0.48$  and  $r = 0.59$ , respectively), OT ( $r = 0.44$  and  $r = 0.65$ , respectively), and WIT ( $r = 0.37$  and  $r = 0.47$ , respectively). PADUA score correlated only with WIT ( $r = 0.22$ ). RENAL score correlated with WIT and OT ( $r = 0.33$  and  $r = 0.21$ , respectively). There was no significant correlation between MAP score, OT, EBL, or WIT.

### **3.4. Predictors of postoperative complications**

We performed four separate univariate and multivariate analyses to evaluate the association between VAS, RENAL, PADUA, and MAP scores and the occurrence of complications. In univariate analysis, none of the radiological scores could predict postoperative complications (Supplementary Table 2). In a multivariate analysis adjusted for anticoagulant/antiplatelet treatment, BMI, surgeon's experience, and CCI, only

surgeon's prediction could significantly predict the occurrence of complications (odds ratio = 5.42, 95% confidence interval 4.21–6.31;  $p < 0.001$ ; Table 5).

### **3.5. *Trifecta achievement***

Trifecta was achieved in 60% of the cases. The areas under the curves (AUCs) that represent the ability of radiological scores and surgeon's VAS evaluation to predict trifecta accomplishment are shown in Figure 2. Radiological scores were poor predictors of trifecta accomplishment (AUCs of RENAL, PADUA, and MAP scores were 0.69, 0.67, and 0.41, respectively), while AUCs representing surgeon's intuition to predict pre- and postoperative trifecta were 0.76 and 0.77, respectively.

## **4. Discussion**

RPN is a technically demanding procedure. Surgical difficulty and postoperative complications can be impacted by many factors: tumour complexity, the presence of adherent perinephric fat, patient's age and comorbidities, as well as the experience and working environment of the surgeon. Scores such as RENAL and PADUA have been designed to objectively evaluate the complexity of the tumour. The MAP score has been reported to be a simple way to predict the presence of adherent perinephric fat that makes it more difficult to expose the tumour. The ability of these scores to predict pre- and postoperative morbidity has been put forward by expert teams [18], but other groups failed to identify such a link [19,20]. Therefore, some surgeons wonder about their usefulness in clinical practice, and guideline committees do not recommend their use.

Our first finding was that surgeon's intuition significantly correlated with all scores (see Table 3), which means that subjective and objective evaluations of surgical complexity are not too far from each other.

Then, our study results showed that surgeon's clinical judgement was better than radiological scores to predict perioperative morbidity of RPN. Pre- and postoperative VAS scores had the strongest correlation with OT, EBL, and WIT (that we considered surrogates of perioperative morbidity). Among radiological scores, RENAL score was most accurate (significantly correlated with OT and WIT), whereas MAP score was not related to any of the perioperative parameters. Similarly, the surgeon was more efficient to predict trifecta achievement, as shown in Figure 1. We believe that this is an interesting finding: surgeons probably have a better overview of the determinants of surgical morbidity such as their experience (how able they are to handle a case), their environment (the team's ability to deal with pre- and postoperative difficulties), and the "real" complexity of a tumour as the surgeon perceives it. Subjective evaluation of surgical difficulty represented by a number on the VAS can be seen as a combination of all these factors.

The intuition of the surgeon was also the best predictor of postoperative complications. We made four models of logistic regression: one for each radiological score to avoid redundancies between clinical parameters that are used in all scores (such as tumour size or location, see Supplementary Table 2). There was no significant association between RENAL, PADUA, or MAP scores and the incidence of complications. In our final multivariate analysis, surgeon's prediction was by far the most important predictor of overall complications (see Table 5).

Anticipating complications can be useful to guide treatment and counsel patients. It is surprising and interesting to see that the surgeon's subjective feeling can much better foresee the occurrence of complications. Indeed, scores do not seem to be very accurate at predicting the postoperative course. The team from Fox Chase reported a strong correlation between tumour complexity and complications when they published their initial study of the RENAL score [18], but other groups failed to identify a similar link [21,22]. Some authors reported an association between patients' comorbidities and complications after RPN [23,24], but this relationship was not confirmed by others [3].

Previous studies examined the value of surgeon's "gut feeling" as a predictor of postoperative outcomes. It was first investigated by Hartley and Sagar [25] in a study that included patients who underwent gastrointestinal surgery. They found that the surgeon's "gut feeling" was a good indicator of a difficult postoperative course. Woodfield et al [26] used a VAS to estimate the postoperative risk of complications before and after abdominal surgery and found that it strongly correlated with the incidence of postoperative complications.

As emphasised earlier, the literature is conflicting regarding the ability of scoring systems to foresee RPN outcomes. One shortcoming of all these scores is that they do not take into account many variables. For example, we may not expect the same results of an RPN for a small 3 cm renal mass performed in a healthy patient as we would in an elderly diabetic patient with a history of many abdominal surgeries and taking an anticoagulant treatment. Clearly no system is able to fully account for all variables (related to patients and their environment). The advantage of scores is that they provide a simple common language that clinicians can use to communicate and compare anatomical complexity of renal masses. Even though one may argue that they were not

designed to predict the primary endpoint that we used (ie, the trifecta), we feel that our study highlights the limited abilities of nephrometry scores to predict RPN outcomes, and in our opinion, these scores provide only trivial information. Our paper underlines the lack of predictive models, and the necessity to build and validate a tool to assess individual patient risk for perioperative complications after RPN.

We did our best to make our results as reliable as possible. First, we collected our data prospectively to avoid biases associated with missing data. Second, radiological scores were calculated before surgery by two independent physicians who were blinded to patients' data. Third, we included all consecutive patients undergoing RPN without any exclusion. However, there are some limitations that must be considered. First, all patients were operated at a single tertiary referral centre, which may have selected more complex cases. In addition, this volume effect could contribute to flaws in our results. The impact of a high-volume centre on perioperative outcomes of RPN has been investigated in several studies. A French multicentre study showed that a higher-volume centre was associated with better perioperative outcomes, including diminished length of stay and morbidity. Most surgeons who made VAS estimations have important experience regarding RPN as they work in a high-volume environment. Predictions of lower-volume providers might be less accurate [27]. Second, although the surgeon's "gut feeling" can be quantified by the use of a VAS, it remains subjective. Third, due to a lack of events, we were unable to assess the accuracy of VAS and morphometry scores to predict major complications. Fourth, we observed a high incidence of pseudoaneurysm in this contemporary experience (6%), which is higher than that reported in previous studies. It could be related to chance and training of junior surgeons. Finally, all

procedures were performed robotically, and the results cannot be applied to open or laparoscopic approaches.

## **5. Conclusions**

Our study showed that surgeon's clinical feeling can better predict perioperative morbidity of RPN than conventional morphological scores. These results should be confirmed by multicentre studies including institutions and surgeons with varied levels of expertise.

**Author contributions:** Zine-Eddine Khene had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

*Study concept and design:* Khene, Peyronnet, Bensalah, Mathieu, Rioux-Leclercq, Verhoest, Shariat.

*Acquisition of data:* Khene, Freton, Grafeille, Robert, Kammerer-Jacquet.

*Analysis and interpretation of data:* Khene, Peyronnet, Bensalah, Shariat, Robert.

*Drafting of the manuscript:* Khene, Peyronnet, Freton, Grafeille.

*Critical revision of the manuscript for important intellectual content:* Bensalah, Rioux-Leclercq, Verhoest, Mathieu, Kammerer-Jacquet, Shariat.

*Statistical analysis:* Khene, Peyronnet, Mathieu.

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**Fig. 1 – Flow chart of patients. RPN = robotic partial nephrectomy.**

**Fig. 2 – Receiver operating characteristic curves for surgeon clinical judgement and radiological scores for the prediction of trifecta accomplishment. ROC = receiver operating characteristic; VAS = visual analogue scale.**

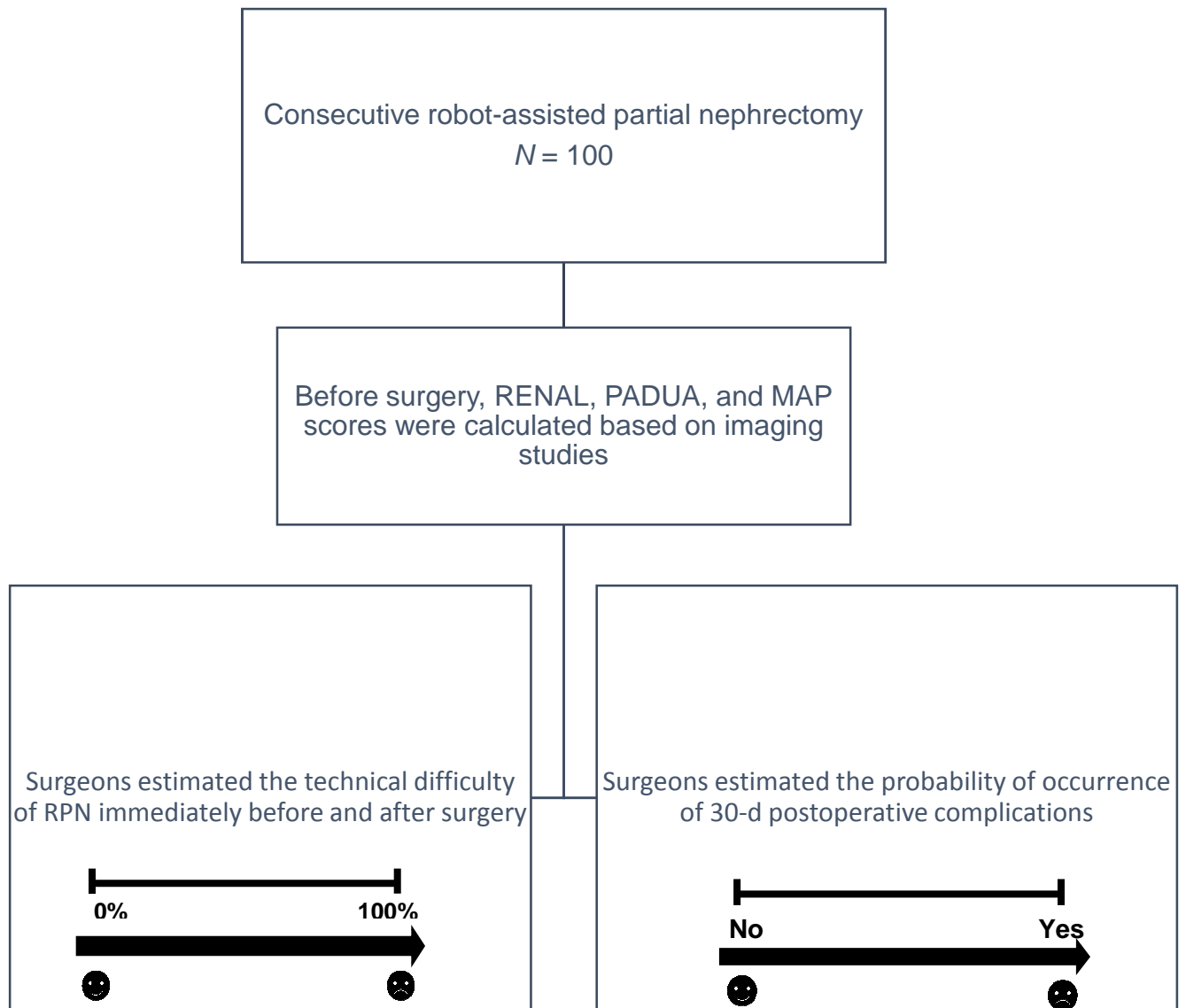


Figure 1

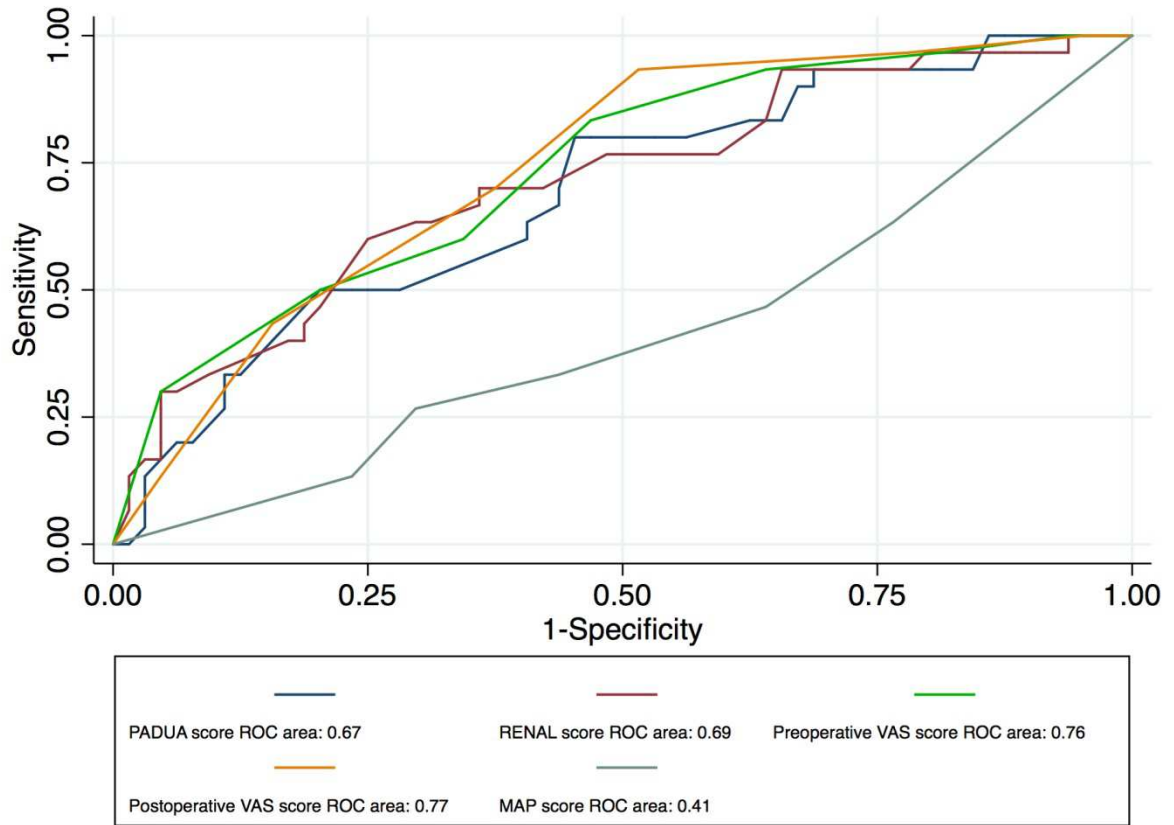


Figure 2

**Table 1 – Patient and tumour characteristics**

No. of pts (%)	100	
Median pt age at surgery (IQR)	59	(49–68)
No. of male (%)	63	(63)
CCI (IQR)	3	(2–5)
Median BMI (kg/m <sup>2</sup> ), (IQR)	26	(23–29)
ASA classification (%)		
1–2	82	(82)
3–4	18	(18)
Anticoagulant/antiplatelet treatments (%)	17	(17)
ECOG (%)		
0	84	(84)
≥1	16	(16)
Median tumour size (mm), (IQR)	40	(26–49)
Tumour side (%)		
Right	51	(51)
Left	49	(49)
Adherent perinephric fat (%)	34	(34)
Surgeon's experience		
High (>100 procedures)	62	(62)
Medium (50–100 procedures)	15	(15)
Low (<50 procedures)	23	(23)
Median operative time (min), (IQR)	140	(100–180)
Median WIT (min), (IQR)	18	(12–22)
Median EBL (ml), (IQR)	270	(150–600)
Mean length of stay (d), (IQR)	2	(1–3)
No. of positive surgical margins (%)	6	(6)
Transfusion (%)	11	(11)
Overall complication (%)	33	(33)
Major complications (%)	11	(11)
No. of tumour pathology (%)		
Malignant	84	(84)
Benign	16	(16)
pT stage (%)		
T1	69	(69)
T2	5	(5)
T3a	10	(10)
Median eGFR variation (ml/min) preop/1 mo postoperatively (IQR)	–2	(–4 to 0)

ASA = American Society of Anesthesiologists; BMI = body mass index; CCI = Charlson comorbidity index; EBL = estimated blood loss; ECOG = Eastern Cooperative Oncology Group; eGFR = estimated glomerular filtration rate; IQR = interquartile range; pt(s) = patient(s); WIT = warm ischemia time.

**Table 2 – Surgeon’s clinical judgement and radiological score characteristics**

Median RENAL score (IQR)	8	(6–10)
RENAL score stratification (%)		
Low (scores 4–6)	30	(30)
Moderate (scores 7–9)	42	(42)
High (scores 10–12)	28	(28)
Median PADUA score (IQR)	9	(8–10)
PADUA score stratification (%)		
Low (scores 6–7)	25	(25)
Moderate (scores 8–9)	40	(40)
High (scores >9)	35	(35)
Median MAP score (IQR)	2	(0–4)
MAP score (%)		
0	31	(31)
1	14	(14)
2	17	(17)
3	11	(11)
4	8	(8)
5	19	(19)
Median preoperative VAS (IQR)	55	(40–70)
Median postoperative VAS (IQR)	60	(50–80)
Surgeons’ subjective prediction of postoperative complication (%)		
Yes	27	(27)
No	73	(73)

IQR = interquartile range; VAS = visual analogue score.

**Table 3 – Correlation between pre- and postoperative VAS and other scoring systems**

	<b>RENAL score</b>		<b>PADUA score</b>		<b>MAP score</b>	
	<i>r</i>	<i>p</i> value	<i>r</i>	<i>p</i> value	<i>r</i>	<i>p</i> value
<b>Preop VAS</b>	0.49	<0.001	0.45	<0.001	0.24	0.02
<b>Postop VAS</b>	0.34	0.005	0.35	0.006	0.25	0.009

VAS = visual analogue score.

**Table 4 – Spearman’s rank correlation coefficients between VAS, PADUA, RENAL, MAP, and OT-EBL-WIT-PSM**

	OT		EBL		WIT		PSM	
	<i>r</i>	<i>p</i> value	<i>r</i>	<i>p</i> value	<i>r</i>	<i>p</i> value	<i>r</i>	<i>p</i> value
<b>RENAL score</b>	<b>0.21</b>	0.04	0.13	0.18	<b>0.33</b>	0.001	0.11	0.41
<b>PADUA score</b>	0.14	0.17	0.15	0.15	<b>0.22</b>	0.03	0.05	0.63
<b>MAP score</b>	0.18	0.07	0.03	0.75	-0.12	0.25	0.09	0.35
<b>Preop VAS</b>	<b>0.44</b>	0.01	<b>0.48</b>	<0.001	<b>0.37</b>	0.002	0.06	0.61
<b>Postop VAS</b>	<b>0.65</b>	<0.001	<b>0.59</b>	<0.001	<b>0.47</b>	<0.001	0.08	0.93

EBL = estimated blood loss; OT = operative time; PSM = positive surgical margin; VAS = visual analogue score; WIT = warm ischaemia time. Significant correlations are marked in bold.

**Table 5 – Logistic regression models to predict overall complications**

Variables	Univariate analysis			Multivariate analysis		
	Odds ratio	95% CI	<i>p</i> value	Odds ratio	95% CI	<i>p</i> value
Surgeon's prediction	4.24	2.67–7.06	0.007	5.42	4.21–6.31	<0.001
Charlson comorbidity index	1.24	1.05–1.49	0.009	1.14	0.91–1.47	0.13
BMI	0.91	0.81–0.99	0.03	0.83	0.72–1.93	0.12
Anticoagulant/antiplatelet treatment	3.73	1.28–11.41	0.01	2.64	0.71–3.30	0.15
Surgeon's experience						
High	Ref					
Medium	0.32	0.07–1.11	0.79	1.24	0.32–4.67	0.74
Low	1.16	0.35–3.64	0.08	3.05	0.77–5.48	0.07

BMI = body mass index; CI = confidence interval; Ref = reference.