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Step-by-Step

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Achieving tumour control when suspecting sinus fat involvement during robot-assisted partial nephrectomy: step-by-step

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Objectives

To report a single expert robotic surgeon's step-by-step surgical technique for achieving local cancer control during robot-assisted PN (RAPN) for T3 tumours.

Patients and methods

Since January 2010 to December 2016, the institutional RAPN database was queried for patients who underwent transperitoneal RAPN performed by a single surgeon for tumours ≤4 mm from the collecting system at preoperative computed tomography (three points on the '*N* [Nearness]' R.E.N.A.L. nephrometry-score item) that were pT3a involving sinus fat at final pathology. Baseline characteristics, perioperative and oncological outcomes (particularly positive surgical margins, PSMs), were identified.

Results

Of 1497 masses that underwent RAPN, 512 scored 3 points on the '*N*' item of the R.E.N.A.L. nephrometry score assessment. In all, 24 patients had pT3a tumours involving sinus fat at final pathology and represented the analysed cohort. RAPN were performed according to the here described technique. No PSMs were reported. Trifecta achievement was 54.2%. Within a median follow-up of 30 months, two and one patients had recurrence or metastasis, respectively. Two patients died unrelated to renal cancer. Retrospective analysis and limited follow-up represent study limitations.

Conclusion

In a selected cohort of patients with renal tumours near the sinus fat at baseline R.E.N.A.L. nephrometry score assessment and confirmed pT3a at final pathology, the described RAPN technique was able to achieve optimal local cancer control.

Keywords

robot, surgical margin, surgical technique, locally advanced, pT3, renal neoplasm

Introduction

Over the past two decades, there has been an increase in the use of partial nephrectomy (PN) for the management of T1 renal masses, particularly at high-volume centres [1,2].

This shift has occurred with the expanding indications for PN in clinical guidelines and with the rapid adoption of robot-assisted renal surgery [3,4].

Although a randomised study failed to show any advantage of PN over radical nephrectomy (RN) in either the survival rates or postoperative kidney function [5,6], most available retrospective studies have reported better renal function and survival outcomes for PN when compared to RN [7–9]. In addition, PN independently protects against both the risk of cardiovascular events and end-stage renal disease, and the consequent need for dialysis relative to RN in patients with localised RCC and preoperative normal kidney function, after accounting for individual baseline characteristics [10]. Moreover, recent reports have suggested that even in patients with T2 masses, PN does not compromise cancer-specific mortality [11].

In contrast, PN is still not considered appropriate management for patients with clinically apparent, locally advanced (T3a) disease, despite outcomes from recent studies reporting similar oncological efficacy of PN vs RN for pT3a tumours [12,13]. However, it is known that a proportion of patients with clinically localised tumours undergoing PN will be upstaged at final pathology [14,15]. Additionally, controversies exist regarding the prognostic distinction between T3a tumours involving the perinephric fat compared with the sinus fat, the latter being more likely to have a negative impact on oncological outcomes [16–18].

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The aim of the present paper and Video S1 was to report the step-by-step surgical technique for achieving cancer control in cases of renal masses suspicious for sinus fat involvement preoperatively, with perioperative outcomes reported.

Patients and methods

Study design

From January 2010 to December 2016, the institutional prospectively maintained PN database (approved by the Institutional Review Board, IRB 5065) was queried for all patients who consecutively underwent robot-assisted PN (RAPN).

Patients who were assigned 3 points on the '*N*' item ('Nearness of the tumour to the collecting system or sinus' of ≤4 mm at preoperative CT) of the R.E.N.A.L. (Radius, Exophytic/Endophytic, Nearness, Anterior/Posterior, Location) nephrometry score calculation represented the analysed cohort [19]. For the purpose of the study, only tumours confirmed to be pT3a due to renal sinus fat invasion at final pathology were considered for the outcomes analysis.

Surgical technique

Our institution's RAPN technique has been previously described [20]. In order to ensure a bloodless field, clamping of the renal artery was performed in all the cases. Warm ischaemia was performed in the majority of the cases. When longer ischaemia time was expected, a cold ischaemia technique was chosen and performed as previously reported [21].

In this study, we report the step-by-step surgical technique developed by one surgeon with consistent expertise in robotic renal surgery (>500 procedures performed) aimed to maximise cancer control in the analysed subgroup of renal masses (for more details see the Video S1).

1. Intraoperative ultrasonography represents a key step before starting the extirpative phase aimed to define the tumour borders. It is important to underline that as renal masses grow, they typically compress the surrounding tissues; however, once there is invasion of the sinus fat, the tumour will often develop an infiltrative growth pattern. Thus, the renal capsule will be interrupted at the level of the sinus fat, which has to be considered a weak point. These macroscopic aspects have to be considered during the resection (Fig. 1).
2. The surgeon has to avoid following the pseudo-capsule plane for the whole resection, in order to ensure a safe margin. Importantly, once the equator of the mass is surpassed, the resection margin has to be widened accordingly, to safeguard against inadverted entry into the tumour capsule. Robotic scissors should be kept straight, avoiding the consistent use of the EndoWrist® in this specific phase (Fig. 2).
3. The non-dominant hand instrument plays a key role in the traction of the mass: while the mass is pulled up by the non-dominant hand robotic grasper, the tensioned parenchymal attachments should be bluntly divided with cold scissors (Fig. 3).
4. This process needs to be done progressively, repeatedly moving from side to side. In this way, the fulcrum of the tension will be focused at the level of the renal sinus (Fig. 4).

Fig. 1 Intraoperative ultrasonography is aimed to define the tumour borders. The renal capsule is found to be interrupted at the level of the sinus fat.

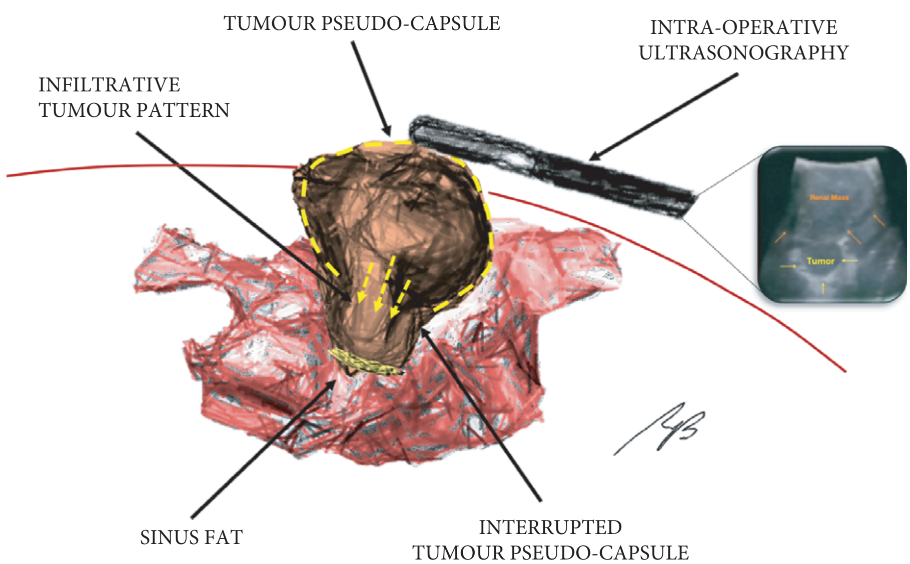


Fig. 2 In order to ensure a safe margin, robotic scissors should be kept straight, avoiding the consistent use of the EndoWrist®.

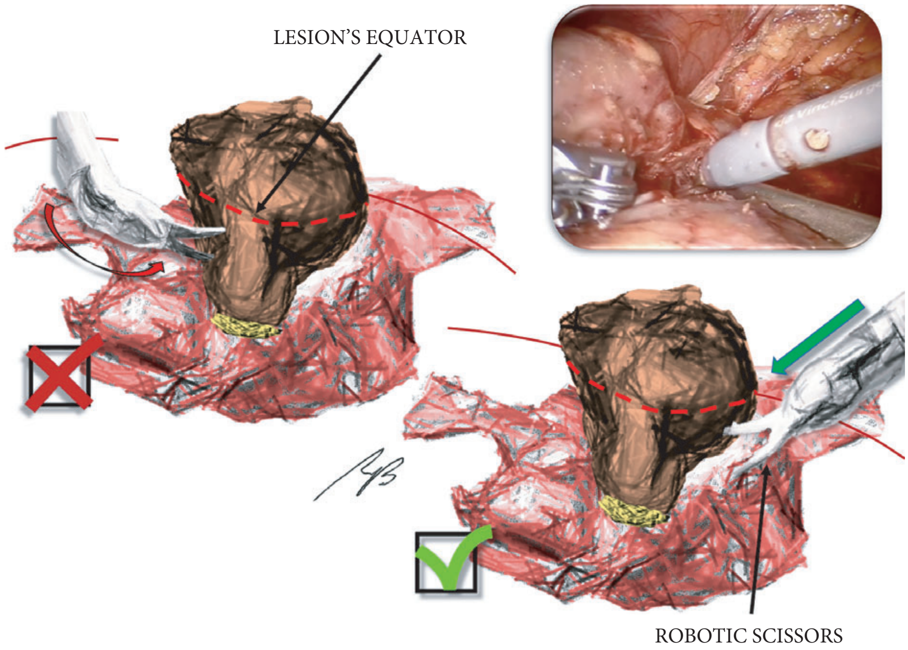
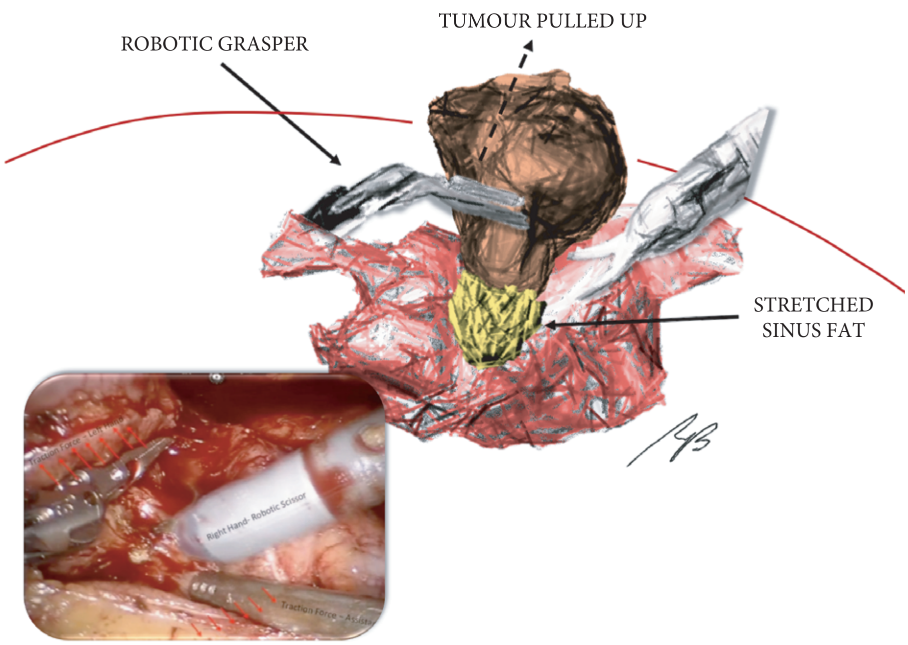


Fig. 3 The mass is pulled up by the non-dominant hand robotic grasper: the lesion's attachments are bluntly divided with cold scissors.



5. During blunt dissection performed with the dorsal aspect of the cold scissors, the inflamed, sclerotic peri-tumoral fat will be more adherent and will guide the surgeon in finding the correct plane for resection. Confirmation of the correct resection plane will be noted with identification of sclerotic fat remaining indivisible from the tumour. Thus, during the final cold cutting, the fatty tissue will remain attached to the tumour edges (Fig. 5).
6. For the renorrhaphy, the deeper layer is the most important in order to avoid a urine leak as urinary collecting system violation is expected.

Fig. 4 Cold scissors should be repeatedly moved from side to side, focusing the fulcrum of the tension at the level of the renal sinus.

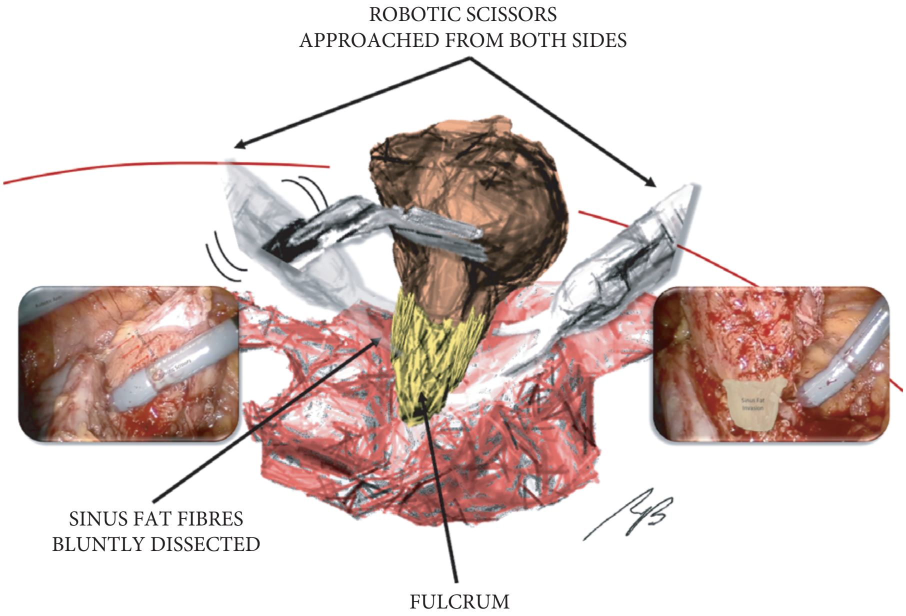
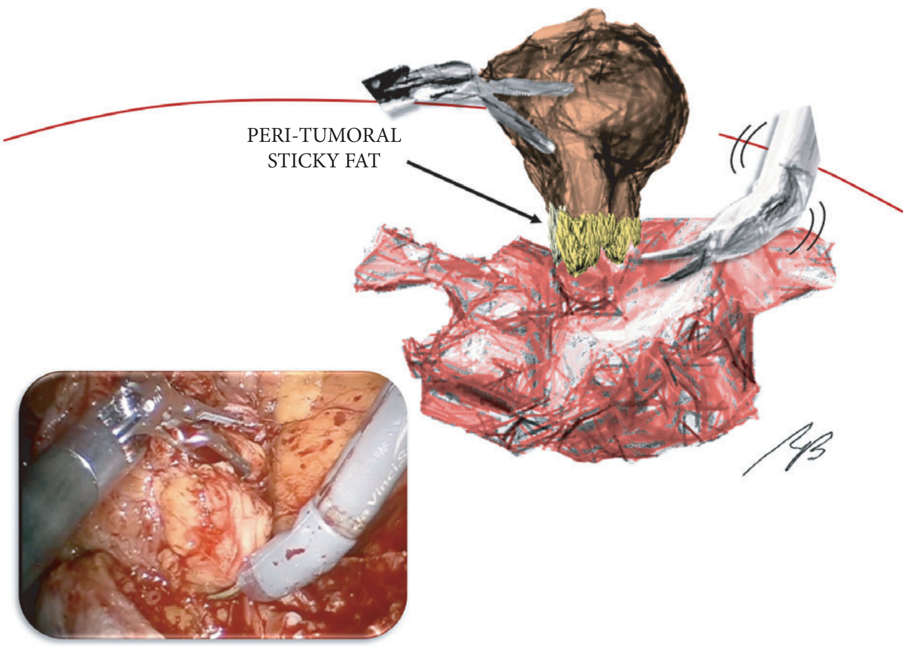


Fig. 5 The inflamed, sclerotic peri-tumoral fat will be more adherent and will guide the surgeon in finding the correct plane for resection. Indeed, sclerotic fat should remain indivisible from the tumour.



Outcome measurements

Patient demographics and preoperative variables were analysed including: age, gender, race, laterality, body mass index (BMI), comorbidities according to the Charlson Comorbidity Index (CCI) [22], preoperative tumour size, R.E.N.A.L. nephrometry score [19], preoperative creatinine and GFR (calculated using the Modification of Diet in Renal Disease equation [23]). Chronic kidney disease (CKD) was staged accordingly. Perioperative variables included: operative time, estimated blood loss, ischaemia time, and intraoperative complications.

Postoperative data included: length of hospital stay, postoperative complications according to the Clavien–Dindo classification [24] (with grade ≥3 considered as major complications). Rates of CKD upstaging were evaluated based on postoperative GFR. As a surrogate of surgical quality, the trifecta of outcomes was used, which included negative surgical margins, no complications, and ischaemia time of <25 min [25].

Pathology assessment

Tumour histology was performed according to the 2004 WHO criteria [26] and grading classified according to Fuhrman et al. [27]. Staging was assigned according to the American Joint Committee on Cancer guidelines [28]. Positive surgical margin (PSM) was assigned accordingly.

Follow-up

The institutional follow-up protocol included a clinical visit, physical examination, and basic metabolic panel at 1–3 and 6 months, then annually. Radiographic evaluation consisted of a minimum of a chest X-ray and abdominal CT or MRI at 6 months, then annually. Local recurrence was defined as a new mass at the previous RAPN surgical bed.

Statistical analysis

Means and standard deviations (SDs) were used to report variables with a normal distribution; medians and interquartile ranges (IQRs) were used for variables with a non-normal distribution. Frequencies and proportions were used to report categorical variables.

The cumulative incidence of local recurrence was calculated and plotted by Kaplan–Meier method. Statistical analysis was performed using Statistica™ 8.0 Software (StatSoft Inc., Tulsa, OK, USA).

Results

Of the 1497 renal masses extracted from the Institutional dataset that underwent RAPN, 512 had ‘*N*’ = 3 at preoperative R.E.N.A.L. nephrometry score assessment. Amongst them, 24 underwent RAPN performed according to the described technique performed by one surgeon and had pT3a RCC at final pathology, representing the analysed cohort, Baseline patients’ characteristics are reported in Table 1.

Table 1 Demographics and preoperative data.

Variable	Value
Number of patients	24
Age, years, mean (SD)	65.3 (12.0)
Sex, *n* (%)	
Female	11 (45.8)
Male	13 (54.2)
BMI, kg/m^2, mean (SD)	31.2 (6.9)
CCI score, median (IQR)	1 (0–2.5)
Diabetes, *n* (%)	
No	20 (83.3)
Yes	4 (16.7)
Hypertension, *n* (%)	
No	10 (41.7)
Yes	14 (58.3)
Hyperlipidaemia, *n* (%)	
No	12 (50.0)
Yes	12 (50.0)
Laterality, *n* (%)	
Right	11 (45.8)
Left	13 (54.2)
Clinical tumour size, cm, mean (SD)	4.40 (1.75)
cT stage, *n* (%)	
T1a	12 (50.0)
T1b	10 (41.7)
T2a	2 (8.3)
R.E.N.A.L. nephrometry score, median (IQR)	9 (8–9.5)
ASA score, median (IQR)	3 (3)
Preoperative haemoglobin, g/dL, median (IQR)	13.7 (13.2–14.7)
Preoperative serum creatinine, mg/dL, median (IQR)	0.92 (0.75–1.09)
Preoperative eGFR, mL/min, median (IQR)	74.5 (55.9–89.7)
CKD stage ≥III, *n* (%)	
No	18 (75.0)
Yes	6 (25.0)

Perioperative data are listed in Table 2. The median (IQR) ischaemia time was 24 (20.75–31) min, with five patients (20.8%) who underwent the cold ischaemia technique. No intraoperative complications were reported. Six patients had postoperative complications, of which three (12.5%) were major. One case (4.2%) was urine leakage undergoing JJ stenting.

Based on estimated GFR (eGFR) values, nine patients (37.5%) had postoperative CKD upstaging.

For pathological findings (Table 3), no patients were found with PSMs. Trifecta was achieved in 13 patients (54.2%).

With a median (IQR) follow-up of 30.1 (11.3–43.9) months, two patients (8.3%) had local recurrence (Fig. 6). One patient (4.2%) had metastasis. Two deaths from other causes were reported but no patients died from renal cancer.

Discussion

Recent studies have reported on the significance of PSMs after PN and the risk of recurrence with a PSM associated with a clinically aggressive tumour. For pT3a tumours, the surgical margin status seems to be not uniformly prognostic and the relationship between PSM and tumour is thought to be influenced by the intrinsic malignant potential of the primary tumour [29]. However, this topic still remains controversial [30,31]. We know from different studies that the PSM rate is high after PN for pT3a and averages 15% in the current literature [16,32].

Table 2 Perioperative data and complications.

Variable	Value
Number of patients	24
Operative time, min, mean (SD)	208 (58)
Estimated blood losses, mL, median (IQR)	225 (87.5–400)
Ischaemia time, min, median (IQR)	24 (20.75–31)
Type of ischaemia, *n* (%)	
Warm	19 (79.2)
Cold	5 (20.8)
Intraoperative complication, *n* (%)	
No	24 (100.0)
Yes	0 (0.0)
Postoperative complication, *n* (%)	
No	18 (75.0)
Yes, minor	3 (12.5)
Yes, major (Clavien ≥3)	3 (12.5)
Of which urine leakage	1 (4.2)
Postoperative haemoglobin, g/dL, median (IQR)	11.4 (10.1–12.4)
Trifecta achievement, *n* (%)	
No	11 (45.8)
Yes	13 (54.2)
Length of stay, days, median (IQR)	3 (3–4)
Postoperative serum creatinine, mg/dL, median (IQR)	
1 month	1.15 (0.81–1.63)
3 months	1.00 (0.91–1.31)
6 months	1.15 (1.13–1.25)
12 months	1.01 (0.89–1.28)
Postoperative eGFR, mL/min, median (IQR)	
1 month	64.6 (37.4–83.4)
3 months	61.2 (50.9–69.4)
6 months	61.8 (51.0–79.9)
12 months	69.7 (48.4–90.5)
Postoperative CKD upstaging, *n* (%)	
No	15 (62.5)
Yes	9 (37.5)

Table 3 Pathological and oncological outcomes.

Variable	Value
Number of patients	24
Tumour size (final pathology), cm, median (IQR)	3.7 (2.8–4.6)
pN stage, *n* (%)	
pNx	18 (75.0)
pN0	5 (20.8)
pN1	1 (4.2)
Cystic features, *n* (%)	
No	18 (75.0)
Yes	6 (25.0)
Histology, *n* (%)	
Clear cell RCC	22 (91.7)
apillary RCC	1 (4.15)
Chromophobe RCC	0 (0.0)
Other malignant	1 (4.15)
Sarcomatoid pattern, *n* (%)	
No	22 (91.7)
Yes	2 (8.3)
Necrosis, *n* (%)	
No	19 (79.2)
Yes	5 (20.8)
Fuhrman grade, *n* (%)	
1–2	7 (29.2)
3–4	17 (70.8)
Margin status, *n* (%)	
Negative	24 (100.0)
Positive	0 (0.0)
Follow-up, months, median (IQR)	30.1 (11.3–43.9)
Local recurrence, *n* (%)	
No	22 (91.7)
Yes	2 (8.3)
Metastasis, *n* (%)	
No	23 (95.6)
Yes	1 (4.2)
Death, *n* (%)	
Due to RCC	0 (0.0)
Other cause	2 (8.3)

The present results, from the review of the here-reported single-surgeon surgical technique, appear superior to those reported in the available literature, with a 0% rate of PSMs in a selected cohort of patients with pT3a tumours due to renal sinus fat invasion. Conversely, the overall rate of PSM in the RAPN institutional database is 11.6%, which is consistent with the literature. Indeed, in a recent single-institution analysis, Mouracade et al. [33] evaluated the oncological outcome of >1000 patients with cT1 staged renal masses and the predictors of pT3a upstaging after PN. In their analysis, PN for pT3a tumours had an 18.6% PSM rate. In a multicentre retrospective survey, Bensalah et al. [31] analysed 111 patients with PSM, concluding that a PSM is more likely to occur in cases of absolute indication, as could be the case of more complex renal lesions. Nevertheless, the authors stated that the PSM status does not influence cancer-specific survival, although there was an increased risk of recurrence instead. Accordingly, Khalifeh et al. [34] found an 18-fold higher risk of recurrence in cases of PSM, after adjusting for multiple tumours, tumour size, growth pattern, and pathological stage.

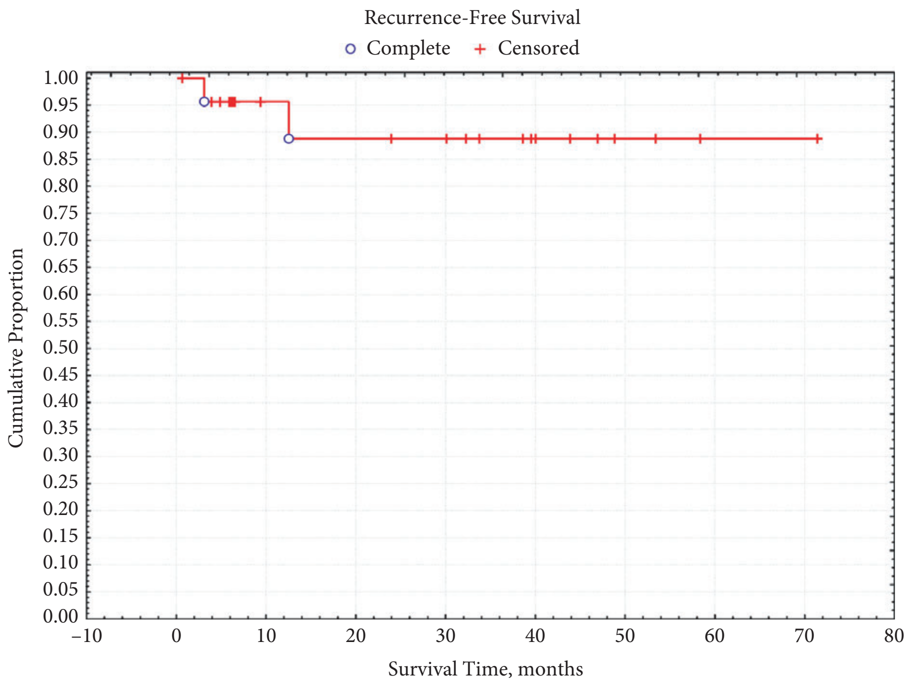
The important finding of the present paper is that the described technique for dealing with high-risk tumours with sinus fat invasion may be advantageous for achieving local cancer control. The surgical margins status translated into a satisfactory trifecta achievement rate (54.2%).

Such a trifecta rate is comparable to the overall rates reported in the literature for RAPN, regardless of the pathological stage. In the first study specifically evaluating trifecta achievement after RAPN for high-complexity renal masses, Abdel Raheem et al. [35] published a rate of 37.5%. Arora et al. [36] reported a 57.6% rate of trifecta outcome in a recent analysis of the Vattikuti Quality Initiative Database of RAPN for renal masses in solitary kidney for T1–T2 renal masses. We underline that the tumours reported in the present case series should be considered as complex due to the confirmed renal sinus fat invasion. Moreover, the median (IQR) R.E.N.A.L. nephrometry score was 9 (8–9.5), thus confirming moderate-to-high complexity renal masses.

The findings from the present evaluation seem to be consistent with previous literature reports that have underlined the importance of surgeon experience and lesion complexity in predicting the surgical outcome [37].

Our present study is not devoid of limitations. First, the retrospective design may not account for inherent biases.

Fig. 6 Kaplan–Meier curve showing the cumulative proportion of recurrence-free patients.



Second, to include a control group was beyond the purpose of the study. The impact of the surgeon's experience on the impressive results is undoubted but there is certainly the potential that additional factors may have contributed to our outcomes. Third, one could argue that the choice of a R.E.N.A.L. nephrometry score parameter of '*N*' = 3 as a criterion for implementing the described technique appears arbitrary. However, in the surgeon's anecdotal experience, after approaching all '*N*' = 3 renal masses with the reported technique, the PSM rate has decreased. According to our data, the use of such a parameter has high sensitivity but low specificity in predicting pT3a tumour involving the sinus fat at final pathology. Ideally in the future, we will have a standardised method to predict the likelihood of sinus fat involvement, as preoperative imaging is not always reliable. Fourth, concerning the evaluation of renal function, we concur that while the use of eGFR is a practical option, ideally a nuclear renal scan should be adopted [23]. However, this was not available for the majority of the analysed patients.

Notwithstanding these limitations, we sincerely believe that the present report and particularly the related video could represent a valuable tool for both the expert and the less experienced robotic surgeon, aimed to achieve local cancer control even in the case of more challenging tumours involving the sinus fat. This may be particularly helpful in cases of absolute indications for PN, such as solitary kidney. We are unable to draw definitive conclusions about the oncological follow-up as longer follow-up is required to better define the actual advantage of the negative margin status for T3a tumours involving the sinus fat. There are a number of possible explanations for oncological recurrence in the setting of negative surgical margins, including the growth of a new primary tumour, as well as undetected malignancy at the edge of resection of the pathological specimen (false-negative surgical margin). Alternatively, there may be small nests of malignant tissue resting outside of the perceived tumour boundaries defined at the time of surgery.

Nonetheless, the main aim of the present study was to highlight a step-by-step description of a modified surgical technique for complex renal tumours involving the sinus fat.

In conclusion, the herein reported technique for RAPN may optimise cancer control in a selected cohort of patients with renal tumours involving the sinus fat. Longer follow-up is mandatory to better evaluate the implications of a negative margin status for pT3a tumours. Comparative studies are needed to confirm the superiority of the described technique.

Conflict of Interest

Jihad H. Kaouk certifies that all conflicts of interest, including specific financial interests and relationships and affiliations relevant to the subject matter or materials discussed in the manuscript (e.g. employment/affiliation, grants or funding, consultancies, honoraria, stock ownership or options, expert testimony, royalties, or patent filed, received or pending) are the following: Endocare, Inc, Intuitive. The remaining authors have no conflict of interest.

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Abbreviations: BMI, body mass index; CCI, Charlson Comorbidity Index; CKD, chronic kidney disease; eGFR, estimated GFR; IQR, interquartile range; (RA)PN, (robot-assisted) partial nephrectomy; PSM, positive surgical margin; R.E.N.A.L. Radius, Exophytic/Endophytic, Nearness, Anterior/Posterior, Location (nephrometry score); RN, radical nephrectomy.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Video S1. Step-by-step robot-assisted partial nephrectomy surgical technique for achieving local cancer control for T3 tumours involving the sinus fat.

