



Simultaneous robotic partial nephrectomy for bilateral renal masses

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Abstract

Purpose There is currently no consensus regarding the optimal treatment strategy for patients presenting with synchronous bilateral renal masses. The decision to perform bilateral procedures on the same intervention or in staged procedures is debated. The aim of this manuscript is to analyse the outcomes of simultaneous robot-assisted partial nephrectomy (RAPN) in a series of patients with bilateral renal masses treated at five Italian robotic institutions.

Methods Data from a prospectively maintained multi-institutional database on patients subjected to simultaneous RAPN between November 2011 and July 2019 were reviewed. RAPNs were performed with da Vinci Si or Xi surgical system by expert robotic surgeons. Baseline demographics and clinical features, peri- and post-operative data were collected.

Results Overall, 27 patients underwent simultaneous bilateral RAPN, and 54 RAPNs were performed without need of conversion; median operative time was 250 minutes, median estimated blood loss was 200 mL. Renal artery clamping was needed for 27 (50%) RAPNs with a median warm ischemia time of 15 minutes and no case of acute kidney injury. Complications were reported in 7 (25.9%) patients, mainly represented by Clavien 2 events (6 blood transfusions). Positive surgical margins were assessed in 2 (3.7%) of the renal cell carcinoma. At the median follow-up of 30 months, recurrence-free survival was 100%.

Conclusion Our data showed that, in selected patients and expert hands, simultaneous bilateral RAPNs could be a safe and feasible procedure with promising results for the treatment of bilateral synchronous renal masses.

Keywords Robotic surgical procedures · Nephrectomy · Carcinoma · Renal cell · Robotics

Introduction

Nearly 1–5% of kidney cancer diagnoses are in patients with a synchronous bilateral disease [1, 2]. Since the cases reported in the literature are very few, there is currently no consensus regarding the optimal treatment strategy for

patients presenting with synchronous bilateral renal masses. Indeed, in these cases, minimizing the postoperative renal function loss has a particular importance while preserving a complete eradication of the renal tumor. For this reason, if technically feasible, the preservation of both kidneys through a bilateral partial nephrectomy (PN) would be the preferred

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strategy to improve the functional outcome, compared to performing a radical nephrectomy (RN) on the side of the tumor with the worst nephrometric characteristics and a PN on the other side [3, 4]. The decision to perform bilateral procedures during the same intervention or in staged procedures is generally based on surgeon choice considering the characteristics of both renal masses, the surgeons' experience and the centre volume. The potential benefits of simultaneous surgery could be related to the advantages of a unique procedure with single anaesthesia time, shorter overall hospitalization, faster overall recovery and lower costs than two separate procedures. Moreover, a single-step strategy might have an impact on oncological outcomes, avoiding delay due to the second procedure. However, these advantages could be balanced by the potential risks of increased perioperative surgical complications and significant detriments to renal function due to possible bilateral clamping approaches leading to a hypothetical higher acute kidney injury (AKI) rate. To date, there are very few data on the outcomes of patients undergoing simultaneous bilateral nephron-sparing procedures [5–7]. In the last decade, robot-assisted PN (RAPN) has been able to bridge the technical difficulties of laparoscopic partial nephrectomy (LPN) allowing an exponential diffusion of the minimally invasive treatment of renal masses [8–11]. As such, this surgical approach has also been expanded to the treatment of bilateral renal tumors [12–14].

The aim of the present study was to analyse the surgical outcomes of patients with synchronous bilateral renal masses treated with simultaneous bilateral RAPN at five Italian robotic institutions.

Materials and methods

We retrospectively reviewed our prospectively maintained multi-institutional database of patients with clinically localized renal tumors treated with PN between November 2011 and July 2019; the patients were registered at five Italian urologic robotic centers (Careggi University Hospital, Florence; Santa Chiara Hospital, Trento; San Paolo Hospital, Savona; SS. Annunziata Hospital, Chieti, Niguarda Hospital, Milan) from the Italian Group for Advanced Laparoscopic and Robotic urologic Surgery (AGILE group—www.agilegroup.it). The AGILE group is a multicenter non-profit consortium with scientific, educational and training purposes, grouping several urological departments and clinics across Italy.

Among these patients, 60 were diagnosed with synchronous non-familiar bilateral masses, of which 27 (45%) underwent simultaneous bilateral RAPNs and were evaluated in the present study. The remaining 33 patients (55%) underwent staged PN either open or laparoscopic or robotic.

All the patients had preoperative imaging examinations with CT and/or MRI which showed bilateral renal masses suspicious for malignancy. The surgical technique of simultaneous RAPN has already been published [13]. All the procedures were performed by expert robotic surgeons. Intra- and postoperative outcomes were recorded. AKI was defined according to the risk/injury/failure/loss/end-stage (RIFLE) criteria using postoperative renal function up to the third postoperative day. Renal function was measured as glomerular filtration rate (eGFR) estimated using the Chronic Kidney Disease Epidemiology Collaboration equation (CKDEPI). Functional outcome was measured as the relative reduction in eGFR and decreases in eGFR $\geq 25\%$ from baseline according to the definition of progression to CKD of the National Institute for Health and Care Excellence (NICE) guidelines [15]. Postoperative complications were assessed according to the Clavien–Dindo classification [16]. All the surgical specimens were evaluated by staff pathologists with specialized training in genitourinary cancers. Oncological follow-up was based on the European Association of Urology guidelines recommendations [17]. For statistical purposes, independent variables included all patient- and tumor-related data available in our multi-institutional database. Descriptive statistics were obtained reporting medians and interquartile ranges (IQR) for continuous variables, and frequencies and proportions for categorical variables, as appropriate. Statistical analyses were performed using SPSS v. 24 (IBM SPSS Statistics for Mac, Armonk, NY, IBM Corp).

Results

Baseline demographics and clinical features are reported in Table 1. Overall, 27 patients underwent simultaneous bilateral RAPNs and 54 RAPNs were performed. Among the 27 patients, 19 (70.3%) were male, the median (IQR) age was 65 (58–68) years and the median (IQR) BMI was 27 (24–31) kg/m². Based on the Charlson comorbidity evaluation, an index of 0–1 was assigned to 9 (33.3%) patients, an index of 2–3 to 14 (51.9%) patients, an index of 4–5 to 2 (7.4%) patients and an index ≥ 6 to 2 (7.4%) patients. The median (IQR) preoperative eGFR value was 86.7 (79.0–103.6) mL/min. The median (IQR) serum haemoglobin value was 15.5 (14.4–16.1) g/dL. Regarding assessment of the renal masses, the median clinical mass size (IQR) was 25 (20–31) mm. The PADUA score was 6–7, 8–9 and ≥ 10 in 35 (64.8%), 17 (31.5%) and 2 (3.7%) renal masses, respectively. The RENAL score was 4–6, 7–9 and 10–12 in 35 (64.8%), 18 (33.3%) and 1 (1.9%) renal masses, respectively.

Perioperative outcomes are reported in Table 2. A transperitoneal surgical approach was chosen for 52 procedures (96.2%) while a retroperitoneal approach was only

Table 1 Baseline demographics and clinical features of the study population

Number of patients	27
Number of RAPNs	54
Gender, n (%)	
Male	19 (70.3)
Female	8 (29.7)
Age, median (IQR) years	65 (58–68)
BMI, median (IQR) Kg/m ²	27 (24–31)
ASA score, n (%)	
1	3 (11.1)
2	17 (62.9)
3	7 (26.0)
≥4	0 (0)
Charlson comorbidity index, n (%)	
0–1	9 (33.3)
2–3	14 (51.9)
4–5	2 (7.4)
≥6	2 (7.4)
Clinical mass size, median (IQR) (mm)	25 (20–31)
PADUA score categories of the tumors, n (%)	
6–7	35 (64.8)
8–9	17 (31.5)
≥10	2 (3.7)
RENAL score categories of the tumors, n (%)	
4–6	35 (64.8)
7–9	18 (33.3)
10–12	1 (1.9)
a	29 (53.7)
p	9 (16.7)
x	16 (29.6)
eGFR, median (IQR) (mL/min)	86.7 (79.0–103.6)
Serum haemoglobin, median (IQR) (g/dL)	15.5 (14.4–16.1)

RAPNs robot-assisted partial nephrectomies, *IQR* interquartile range, *BMI* body mass index, *ASA score* American Society of Anesthesiologists score, *PADUA score* Preoperative Aspects and Dimensions Used for an Anatomical score, *eGFR* estimated glomerular filtration rate

performed in 2 cases (3.8%). The surgical strategy started from the mass with the higher PADUA score in 11 patients (40.8%) and from the mass with the lower PADUA score in 10 patients (37.0%). In the remaining 6 patients (22.2%), the PADUA scores were equal. A renal artery clamping was needed for 27 (50%) RAPNs with a median (IQR) warm ischemia time (WIT) of 15 (12–22) minutes. With regard to the clamping strategy, bilateral main or selective clamping procedures were performed in 4 (14.8%) and 2 (7.4%) patients, respectively, while a monolateral clamping procedure was performed in 15 (55.6%) patients and a bilateral clampless procedure was chosen in 6 cases (22.2%).

The overall median (IQR) operative time (OT) was 250 (200–320) minutes and the overall median (IQR) estimated

blood loss (EBL) was 200 (150–400) mL. All procedures were completed without the need of conversion to open surgery.

The eGFR started with a preoperative median (IQR) of 86.7 (79.0–103.6), decreased to 64.8 (58.0–81.0) mL/min at day 1 after surgery and tended to improve to 66.2 (58.2–81.6) mL/min and 73.4 (59.2–83.4) mL/min at discharge and at the last follow-up visit, respectively. None of the patients had postoperative AKI.

Overall, we reported 7 (25.9%) complications. In particular, a Clavien 2 event was assessed in 6 (22.2%) patients represented by 3 cases (11.1%) of fever, cured with antibiotic therapy and 3 cases (11.1%) of bleeding, which required blood transfusions. A Clavien 3 event occurred in 1 (3.7%) patient due to urinary leakage from the renorrhaphy with the development of a perirenal urinoma which required a ureteral stent.

The pathological examination showed a median (IQR) tumor size of 22 (18–30) mm and confirmed a renal cell cancer (RCC) in 37 (68.5%) masses. Histological diagnosis, staging and grading details are shown in Table 3. Positive surgical margins were assessed in 2 (3.7%) of the RCCs. Benign lesions were represented by oncocytoma and hemorrhagic cysts in 13 (24%) and 4 (7.5%) cases, respectively. None of the patients reported bilateral benign masses. Histological discrepancy rate between the two lesions was 29.6%.

At the median follow-up (IQR) of 30 (5–52) months, the recurrence-free survival was 100%.

Discussion

Simultaneous bilateral PN is a challenging procedure for the treatment of synchronous bilateral renal tumors. We evaluated the perioperative and functional outcomes of patients undergoing this procedure at five Italian robotic centers performed by highly experienced robotic surgeons. To our knowledge, only a few case reports of simultaneous bilateral RAPNs have been published in literature and our study is the largest series reported on this topic [12–14, 18].

As expected, patients subjected to a bilateral simultaneous surgical procedure showed favourable BMI (27 kg/m²), low ASA (score 1 and 2 in 74% patients), low Charlson (≤ 3 in 85.2% of patients) scores and adequate renal function (86.7 ml/min). Along with these preoperative patient characteristics, the main surgical selection criteria were represented by the high likelihood to avoid bilateral main artery clamping in the preoperative planning. However, although lower nephrometry scores were attributed to the majority of renal masses, both PADUA and RENAL classifications reported more than 35% of moderate–high complexity lesions, showing different degrees of risk in terms of perioperative complications.

Table 2 Perioperative outcomes

<i>Intraoperative variables</i>		
Surgical approach, n (%)	Transperitoneal	52 (96.2)
Surgical strategy, 1st step n (%)	Retroperitoneal	2 (3.8)
Clamping approach, n (%)	High Padua score	11 (40.8)
Venous clamping, n (%)	Low Padua score	10 (37.0)
WIT, including selective artery clamping, median (IQR) min	Equal Padua score (not applicable)	6 (22.2)
Overall OT, median (IQR) min	Bilateral main artery clamping	4 (14.8)
Overall EBL, median (IQR) mL	Bilateral selective artery clamping	2 (7.4)
Conversion to open surgery, n (%)	Monolateral main artery clamping	15 (55.6)
<i>Postoperative variables</i>	Bilateral artery clampless	6 (22.2)
eGFR, median (IQR) mL/min	1 day after surgery	64.8 (58.0–81.0)
Complications (Clavien–Dindo classification), n (%)	Discharge	66.2 (58.2–81.6)
LOS median (IQR) days	Last follow-up visit	73.4 (59.2–83.4)
Pathological tumor size, median (IQR) mm	I	0 (0)
Pathology result, n (%)	II (fever, bleeding)	6 (22.2)
Histological discrepancy between the two lesions, n (%)	IIIa (urinary leakage)	1 (3.7)
Median follow-up (IQR) months	Renal cell cancer	6 (5–9)
	Benign histology	22 (18–30)
		37 (68.5)
		17 (31.5)
		8 (29.6)
		30 (5–52)

RAPN robot-assisted partial nephrectomy, *PADUA score* Preoperative Aspects and Dimensions Used for an Anatomical score, *OT* operative time, *IQR* interquartile range, *WIT* warm ischemia time, *EBL* estimated blood loss, *eGFR* estimated glomerular filtration rate, *LOS* length of stay
OT and EBL only concerned the simultaneous procedure

Table 3 Histological diagnosis, pathologic staging, grading and positive surgical margins of the 37 RCCs

Histological diagnosis, n (%)	
Clear-cell RCC	32 (86.5)
Papillary RCC	4 (10.8)
Chromophobe RCC	1 (2.7)
Pathologic stage, n (%)	
pT1a	32 (86.5)
pT1b	5 (13.5)
Fuhrman grade, n (%)	
G1	8 (21.6)
G2	26 (70.3)
G3	3 (8.1)
Positive surgical margins, n (%)	
	2 (3.7)

RCC renal cell cancer

Regarding the intraoperative outcomes, all bilateral RAPNs were completed without need of conversion, with

median OTs, WITs and EBLs in line with the literature showing the feasibility of this procedure in expert hands [8, 9, 11, 19]. In particular, main renal or selective artery clamping was performed in 50% of procedures with an overall median (IQR) WIT of 15 (12–22) minutes. The careful avoidance whenever possible of bilateral main artery clamping, which occurred in only 4 cases, protected the patients from the onset of postoperative AKI and from substantial decrease of postoperative eGFR. Actually, an expected decrease of the eGFR was observed. However, a similar decline of renal function has already been reported by some authors after monolateral and bilateral staged partial nephrectomies [20–23]. Furthermore, in our experience, the median eGFR values tended to improve in the follow-up and none of the patients progressed to AKI. Our results suggest that simultaneous bilateral RAPNs can be performed in selected patients without undue concern for the effects on renal function and its implications. Notably, in our study population, the median eGFR baseline value was 86.7 mL/

min; thus, our results might not be generalizable to patients with a poorer preoperative renal function or more complex tumors which could require a clamping with longer ischemia times.

As regards postoperative complications, the potential for an increased proportion and severity of them when performing a bilateral synchronous procedure may be a concern, particularly with regard to the increased risk of postoperative renal hemorrhage. However, the overall complication rate (25.9%) reported in the present study was in line with those reported in elective monolateral RAPN series and consisted of 6 (22.2%) and 1 (3.7%) Clavien–Dindo II and IIIa events, respectively. As previously stated, similar complication rates have already been reported after unilateral or simultaneous bilateral procedures [19, 21, 23, 24]. Concerning the median LOS, although in some series it was shorter than six days, especially after unilateral procedures, other papers regarding bilateral PNs have already reported hospitalization times similar to our experience [6, 18, 21]. Based on these aspects, we think that our experience showed the safety of simultaneous bilateral RAPN in the hands of expert surgeons.

Concerning oncological aspects, our data confirmed a renal cell cancer in 68.5% of renal masses. Actually, the rate of benign lesions (31.5%) is higher than that reported in other series after partial nephrectomies and is probably due to the limits of traditional imaging for differentiating oncocytoma from malignant renal neoplasms, especially in cases of small bilateral masses [25, 26]. In our series, characterization of the masses was made using CT and/or MRI and we did not routinely perform preoperative renal biopsies due to the lack of conclusive data on the accuracy of renal tumor biopsy in determining some tumor histotypes or grading in light of tumor heterogeneity and the possibility of histological discrepancy in synchronous bilateral tumors, which amounted to 29.6% in our series. Furthermore, a higher risk of complications should be considered in cases of bilateral renal biopsies with respect to unilateral procedure [27, 28]. The positive surgical margin rate (3.7%) found in this cohort of patients was similar to that reported in most of the larger series of RAPNs [8, 11, 19, 29, 30]. The recurrence-free survival was favourable considering the staging of the tumors and the medium-term follow-up.

Our study is not devoid of limitations. First, this was a retrospective study of a prospectively maintained database. Second, our study population was represented by a limited group of patients who underwent a complex surgical procedure by expert robotic surgeons. Thus, our results should be interpreted cautiously because they could be influenced by the experience of the surgeons or the surgical volume of each robotic center and cannot be generalizable to all the categories of patients or centers with lower experience/volumes. Third, the study population came from different institutions; indeed, this aspect allowed us to increase the

number of patients undergoing this particular procedure but it also potentially increased the heterogeneity in terms of surgical technique adopted. Fourth, we did not perform routinely renogram scans and the use of this procedure could have provided data regarding the split renal function. Fifth, no comparison with patients undergoing bilateral staged RAPN was planned.

Conclusions

Our data showed that, in selected patients and expert hands, simultaneous bilateral RAPNs could be a safe and feasible procedure with promising results for the treatment of bilateral synchronous renal masses.

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Author contributions FG and SS: protocol/project development, data analysis, and manuscript writing/editing. LL, DM, PB, AM, FDM, LC, AG, GP, and GM: data analysis and supervision. AA, MS, LS, FA, CT, AMB, and FG: supervision. AM: protocol/project development, manuscript writing/editing, and supervision.

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